Volume 1 June 1955 No. 3

Canadian Aeronautical Journal

CONTENTS

Published by the
CANADIAN AERONAUTICAL INSTITUTE
304 Laurier Avenue West
OTTAWA

CANADIAN AERONAUTICAL INSTITUTE

COUNCIL 1955-56

CANADIAN AERONAUTICAL JOURNAL

Publications Committee:
G/C H. R. Foottit
Mr. H. C. Oatway
Mr. J. Lukasiewicz
F/L W. M. McLeish
All communications should be addressed to The Secretary.

Subscription—$4.00 per year
Single copy—50 cents

The Institute is not responsible for statements or opinions expressed in papers or discussions printed in its publications.

Authorized as second class mail, Post Office Department, Ottawa

Printed by The Runge Press Ltd., Ottawa, Ontario, Canada

THE PRESIDENT 1955-56

EDITORIAL

THE PRESIDENT'S MESSAGE

As the Canadian Aeronautical Institute enters its second year it is time to consider its position both with relation to the past and the future. Looking back we find that last year was one of transition where the organization grew from an embryo into its present phase of development. During this period the 1954 Council was confronted with directing the policies of the Institute without the benefit of precedent or tradition. The competency with which they performed this function is evidenced by our present robust state.

The second Annual General Meeting which took place in May, the high quality of the technical papers presented at this function and the standard exhibited by the Journal are all proof that the Canadian Aeronautical Institute is on the threshold of maturity. They also are representative of the tangible benefits which the Institute can now offer its members.

The new Council met for the first time immediately following the Annual Meeting to lay the foundations for this year's program. In addition to the Committees on Admissions, Publications and Finance, two new ones were authorized,—one to study the problems associated with the training of aeronautical technical personnel, and the other to co-ordinate the activities of the Branches and to direct the planning of the joint I.A.S./C.A.I. meeting in the fall and the Annual Meeting next spring.

The newly elected Branch Executives are presently planning their programs to meet the individual interests of their areas. To assist them in accomplishing their objective, members should acquaint their local Program Committees with their interest and where possible, participate in the Branch activities. In this manner the C.A.I. may best fulfill its intention of being of benefit to all technical personnel concerned with aeronautics.

The membership growth from the inception has been remarkable and is indicative of the need for our organization. Potentially there are hundreds if not thousands of personnel engaged in aeronautics who are eligible for membership and who have not yet joined. These individuals should be encouraged to become members, not solely for the purpose of increasing the membership but so that they may contribute their knowledge to us and we in turn to them. Two new Branches have been recently established and we may reasonably expect that others will be brought forth during the coming months.

The C.A.I.'s growth and achievements, of which we can be justly proud, are directly attributable to the energy and inspiration of its members. The future is promising and the confidence which has been displayed by both the individual and sustaining members poses a challenge to the Council and myself which we look forward to with enthusiasm and vigor.

R. D. Richmond
President 1955-56

THE PRESIDENT'S BADGE

WHEN the Canadian Aeronautical Institute was founded in 1954 Mr. G. H. Dowty, Chairman and Managing Director of the Dowty Group of Companies and a Past President of the Royal Aeronautical Society, generously offered to present a President's Badge to the new organization. His offer was gratefully accepted by the Council.

Work on the design and manufacture of the Badge was then put in hand. It was completed in time to be presented to the first President of the C.A.I., Dr. J. J. Green, at the conclusion of his term of office at the Annual General Meeting held in Toronto on the 19th/20th May 1955. The presentation was made on Mr. Dowty's behalf by Mr. R. F. Hunt.

Mr. G. H. Dowty

The President's Badge

THE BADGE

The Badge is made of silver-gilt and enamel and bears the emblem of the Institute in full colour on its face. On the back of the Badge is the inscription "Presented by G. H. Dowty 1955".

The Badge is supported on a pendant from a blue enamel monogram of the C.A.I. which closes a chain, also of silver-gilt, comprising ten rectangular plates on which the names of the succeeding Presidents are to be inscribed. One of these plates now bears the inscription "John J. Green 1954-55".

DESIGN AND MANUFACTURE

The Badge was designed by Allan G. Wyon, Fellow of the Royal Society of British Sculptors, who also designed the President's Badge of the Royal Aeronautical Society. Medals and Seals of his design are in the British Museum and he has also designed many Mural Memorial Tablets in the Cathedrals of England. It is of interest to note that the Wyon Family has been engaged on this type of artistic work for 150 years.

The Badge was made by G. T. Friend of London with the collaboration of various craftsmen and under the close supervision of the designer.

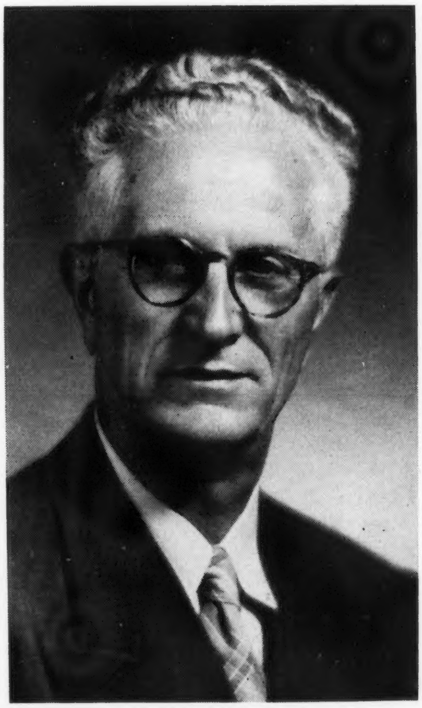
THE DONOR

Mr. G. H. Dowty was born and educated in Worcester. From 1918 to 1931 he worked with Heenan and Froude, British Aerial Transport, Dunlop Rubber, A. V. Roe and Gloster Aircraft. In 1931 he founded the group of companies which bears his name. He was elected President of the R.Ae.S. in 1952-53 and is now a member of the Council of the R.Ae.S. and of the S.B.A.C. He is a Fellow of both the R.Ae.S. and the I.A.S. and an Honorary Fellow of the C.A.I.

AIRCRAFT DESIGN POSSIBILITIES OF THE FUTURE†

by Dr. T. P. Wright*

Cornell University



Dr. T. P. Wright

It is an honor and privilege to address you at this dinner. I am delighted to be present at this second annual meeting of the Canadian Aeronautical Institute. Your youthful but distinguished organization derives its name, just as it does its heritage, jointly from the venerable Royal Aeronautical Society and the Institute of the Aeronautical Sciences, now 22 years old. A great many of your members' aeronautical group associations were initially with one or the other or both of these older societies. I, myself, am very proud to be an Honorary Fellow of each of them.

My talk to you will lead up to the implications of its title by outlining some basic concepts in aircraft design and air transportation; by indicating progress that has been made during the past 25 years in several important aspects of these; by discussing the phenomenal growth of air transport; and then showing a probable trend in designs of the future.

†Dinner Address read at the Annual General Meeting of the C.A.I. on the 19th May, 1955, in Toronto.
*Vice-President for Research.

SOME BASIC CONCEPTS

In considering the vehicle of air transportation, the aircraft, we note that during the first 35 years of development since the Wright brothers flew at Kitty Hawk, almost all effort was based on the concept of wing lift generated by a forward velocity caused by a power plant thrust. The engine in the conventional fixed wing aircraft was in a way an accessory of the air frame, although a most important one. In the autogyro of the 1920's a rotating wing was merely substituted for the fixed wing. In either case, major attention was given to the wing.

Then to attain sundry advantages hinted at but not achieved in the autogyro, the engine power was coupled to the rotor and the helicopter came into being—direct vertical ascent and descent was achieved. More recently, we have been regaled by so-called vertical risers, obtaining this capability by the direct thrust of the power plant whether turboprop or turbojet. Thus, the engine steps into the all-important role with the wing attached as an accessory. In cogitating over this shift in roles, Dr. Theodore von Kármán put the matter neatly (as is his wont) by saying: "We are approaching the age of the motorist as distinguished from the aerodynamicist".

Possibly a true marriage of the two will eventually occur in the lift-power integration concept, discussed more and more in the aviation press, with considerable experimentation conducted to back up the statement of possibilities. One configuration being considered in France is called the coleopter, a shrouded jet engine.

Now let us turn from the vehicle to one of its major qualities—speed. This characteristic I consider to be the raison d'être of aviation. Its range is from top to stalling. From the standpoint of air transport operations, however, the top speed is reduced to cruising speed and then to block-to-block speed to account for time lost in landing. Actually, from the standpoint of the passenger desiring to go from the Royal York Hotel in Toronto to the Hotel Astor in Times Square in New

York, or for that matter, from the latter place to the Hyde Park Hotel in London, we have in each case an onerous bus or airport limousine trip to make. This 1½ hours or more lost time on each trip becomes more and more significant as air speeds increase. It was not considered too bad when flying from coast to coast in 17 hours in a DC-3, but when the airport to airport time is 8 hours in a Constellation, DC-7 or Viscount, it is resented; and when in a few years, this time is reduced to 5 hours (or New York to London in 7), then surely we will demand that something be done about it.

Even more detrimental to city to city time is the airport to city increments in local service air transportation. A Buffalo to New York 2½ hour air trip with 4 intermediate stops is increased by 60% to 4 hours for the man going from Niagara Square to Times Square.

All of this means we must consider speeds in terms of "city block to city block", to coin a phrase, rather than airport chock to airport chock. One approach is the more intensive study of the lower end of the speed range. We must reduce landing speeds with zero as our goal and, as well, approach vertical take-off. Airplanes having these qualities are referred to in a recent report of the Cornell-Guggenheim Aviation Safety Center as Steep Gradient Aircraft. The social aspects in city planning and economic aspects of reduced runway lengths and airport relocations are there described.

Air transportation essentially is any transportation but made far faster by inherent speed and terrain obstacle avoidance. It has been said that "the very pace of life depends upon the speed with which matter can be converted into energy available for transportation". Our study of where we are headed in rapid transportation must, however, consider certain characteristics of the aircraft in addition to speed, particularly economy and safety. One assumes that appropriate comfort and reliability will evolve.

PROGRESS

First, let us see how speed has increased through the years. From the Ford Trimotor to the DC-7 we have achieved a speed increase of about 9 miles per year in 27 years, a compounding each year of approximately 5%, to bring cruising speeds from 115 to 360 mph. Competition amongst airlines and designers has played an important part as a forcing function. But whereas, for a variety of reasons, other means of transportation (sea and ground) have stabilized at definite limits in top speed, this is not the case with the air. This is impressive when comparing rail, bus and ship speeds of 60, 50 and 30 mph respectively with the 360 mph of modern air transports.

But we do have worries and hard work ahead to eliminate certain barriers, if limits are to be raised spectacularly hereafter. Our next vintages of aircraft will cruise around 550 mph, as heralded by the Comet and forecast for the Boeing 707. With swept wing configuration and jet engine power, such speeds will be common, surely in 5 to 10 years. The next step thereafter will be to 650 mph where the approach to the sonic barrier and unfavorable economics will bring about a long pause in any further upward speed trend in civil air transportation. Military aircraft have, of course, pierced the sonic barrier already, and this, I feel, foreshadows a like penetration by civil aircraft, but it will take a bit of doing to fly civilly between Mach 1 and 2. If we do, then we hit the so-called thermal barrier. Real trouble is then encountered and in this discussion I will not go further in my forecasting than Mach 2, with a long time period ahead before even Mach 1 will be exceeded regularly by civil aircraft.

In setting time periods for achievement of future improvements in aviation, one may with amusement reflect on the pace-setting rate of the Wright Brothers: Dec. 17, 1903, 10:35 a.m. flight, Orville Wright—120 ft. in 12 seconds at 10 ft. per sec; 12:00 Noon flight, Wilbur Wright—852 ft. in 59 seconds at 14 ft. per sec.; rate of improvement in 1 hour and 25 minutes—speed 45%, endurance 400%; range 600%. Something to shoot for!

Next, I present the record of progress in terms of economy of operation. Possibly the best criterion is passenger fare. This in the United States has stayed roughly constant at 5½¢ per passenger mile since 1938 in spite of a very large inflation of costs. This is about a 5% improvement each year, compounded. Size of equipment for trunk line use has increased since 1930 from 12 seats to 65 or so (averaged) or a 7% increase each year, compounded,—a little more than 2 seats added each year on the average.

There is another aspect of economy or possibly, more accurately,—efficiency—that has for a long time intrigued me. The efficiency of air transport planes for a given range has been measured by the formula *(payload × speed)/operating cost.* This has steadily increased for civil air transports in spite of forecasting limits in speed for supposed economic reasons at constantly recurring intervals. (When we were flying at 200 mph, qualified scientists were placing the top limit at 300). But I think there was confusion between the economy of operation of the plane as distinguished from the operation of the air carrier when apply this formula. Public demand and acceptance of services seemed always to favor the faster plane which stimulated ever increasing speeds. Thus, the airline with the faster equipment got the traffic, increased its load factors and improved its overall economy of operation. Thus, speed should be given an exponent greater than one in the above formula, possibly justifying an efficiency formula for air transportation of $(payload \times speed^2)/operating\ cost$. At any rate, competition has forced speed increases and fares have stayed the same with profits improved.

Evolution along these lines will continue, planes and operations and public acceptance all improving, but now I believe another factor becomes of importance, namely reduced landing speeds aimed towards the in-city, vertical descent objective.

Finally, under this heading of progress, let us look at safety. The achievement in safety improvement is phenomenal. Since 1930, in terms of passenger fatalities for 100,000,000 passenger miles of travel, the record shows a drop from about 22 to 0.09 on the scheduled air carriers in the continental United States in 1954. Including over-ocean operations of these carriers, the 1954 figure was 0.08—about the same as the railroads in an exceptionally good year for them, and many times safer

than automobiles. Reversing the terms of presentation, the progress is measured by 4.5 million passenger miles per passenger fatality in 1930, increasing to 1,250 million passenger miles per passenger fatality in 1954,—a 25% yearly improvement, compounded.

This great record has largely been achieved through the cooperative efforts of many groups, — government, airlines, manufacturers and private associations, such as the two that Jerome Lederer directs—the Cornell-Guggenheim Aviation Safety Center and the Flight Safety Foundation. Recourse to education, information dissemination, research, development and experience exchange have all contributed.

But to improve further, or even to hold our fine present position, new approaches in addition to an intensive continuation of the above will be needed. One is the application of the methods of operational research, so effective in other fields during the war; a second is again to give attention to the low end of the speed range. Thus, we find lower landing speeds, with zero as the objective, favorable in the long run to improvement of speed, economy and safety.

GROWTH OF AIR TRANSPORTATION

Here the record in the form of statistics will best tell the story. In 1930 the U.S. revenue passenger miles flown was 0.08 billion. This increased a little over 0.6 billions per year on the average to achieve the 1954 figure of 16 billion. This represents a 25% yearly increase, compounded. The increase from 1953 to 1954 was 2 billion revenue passenger miles. Transport of air cargo, including freight and express, has also increased since 1938 at a rapid pace, 20% yearly compounded, achieving 184 million ton miles in 1954 from a start of about 12 in 1938, or on the average an increment of 11 million ton miles each year.

Comparisons with other means of transportation are of interest. First, statistics show that there are 4 air carriers in the list of the 6 top common carrier companies in the United States, ranking 2nd, 3rd, 5th and 6th. The Pennsylvania R.R. heads this common carrier group and the N.Y. Central is 4th, behind American and United, and with Eastern Airlines in 5th and TWA 6th place. The spread in passenger miles of this common carrier group of six is small, ranging from 2.85 billion to 3.45 billion in 1954.

Now a second comparison:

INTERCITY PASSENGER MILES IN BILLIONS FOR 1ST CLASS AND COACH TRAFFIC

Type of Transportation	*% of Total*		
	1952	*1953*	*1954*
Airlines	19.8	24.1	28.9
Railroads	46.6	44.3	40.3
Buses	33.6	31.6	30.8

From the above, it would appear by extrapolation that the airlines of the U.S. will carry 1/3 of the common carrier traffic in 1955 with the railroads at 36% and buses at a little over 30%. If this trend should continue still further, then by 1956 the airlines would take the top position at 38% with the railroads and buses about the same at 31%. This table shows a straight line growth for the airlines.

Question may well be asked as to how long such upward trend of air transportation will persist. Surely, it will continue, but at some point, the curve will start to flatten out. The continuing addition of increments of speed coupled with the added convenience of travel caused by steep gradient characteristics achieved in aircraft will work on the side of continuing growth. *Steep gradient aircraft* will make possible a reduction of runway lengths. This in turn will make possible closer-in airports, until finally (when vertical take-offs and landings are practicable), in-city airdromes will be provided, thus, as stated before, adding a real speed increment to air travel.

A look at market potential is required to determine the nature of trip lengths of the future. In 1930 the average trip length of air passengers was 250 miles. This increased to 400 by 1940 and to about 550 in 1945 where it has remained since.

Of all common carrier passengers, only 2.25% of those traveling less than 250 miles travel by air whereas for those traveling over 1000 miles, 74.3% are air passengers. The following table gives approximate percentages of air travel passengers compared to those of all common carriers, for various distance segments:

Distance (in Miles)	*% Air Passengers*	
0- 100	1.2	2.25
101- 250	10.0	
251- 500	23.0	
501-1000	52.0	
1001-1500	63.0	74.3
Above 1500	78.0	

From the above, it is obvious that the air travel percentage now approaching 80% can increase but slowly for the long travel distances. But the air travel market for distances up to 500 miles is barely tapped. So here is the large potential market that can, and I believe will, be invaded by the local service airlines when properly equipped to warrant their growth, meaning the ability to transport people from city center to city center.

How have the improvements in aircraft design, giving enhanced safety, economy and speed been brought about? The answer is by a slow process of evolution, giving many small improvements each year, coupled with occasional innovations of a more revolutionary character. In this category I would list the following:

Lift augmentation—flaps and slots on ever improving aerofoil sections.

Drag reduction—internally braced monoplane wing; retractable landing gear; NACA cowl; smooth skin.

Thrust augmentation—controllable pitch propeller (conceived by your fellow countryman, W. R. Turnbull and developed, with electric drive, in the 1920's with the Curtiss Aeroplane and Motor Co.); the compound piston engine; the gas turbine engine in the turbo-jet and turbo-prop arrangements.

Electronics—Although not an aircraft design feature, there must be included the electronic aids to air navigation and instrument landing which have so enhanced the reliability and present weather free character of flying.

DESIGN POSSIBILITIES OF THE FUTURE

In starting this final discussion of my paper, I would like to recall the basic concepts first stated and considered to be the guide to future design probabilities. These were:

Importance of speed,

Trend toward achievement of steep gradient capabilities,

Trend toward direct thrust lift,

Potential of thrust-lift integration.

Although we will probably tend more and more toward quite radical departures from conventional design as we know it, this will not be easy and we will advance with some reluctance to the rather wierd looking contraptions of the future. Apropos of this resistance to change, I am reminded of the story of the Australian who invented a new type of boomerang. Some days after explaining his discovery to a friend, and outlining its great possibilities with enthusiasm, the latter encountered him again and found him quite crestfallen. The inventor explained that he was downcast because, although his new boomerang had proved all that he had hoped and claimed for it, he nevertheless, was forced to give it up, as he could not get rid of the old one!

Let us now consider future possibilities, dealing with the subject under four categories:

1. Conventional fixed wing aircraft

Transport aircraft much as we know them today will continue in use for the next 10 or 15 years as the predominant type making up the airlines' fleets. But at some point along the way, quite major changes will come into use. Already started is the change in power plants from piston engines to gas turbines. Turbo-props have already found favor on British European Airways, power the Viscounts in Canada and will soon be used by at least one airline in the United States. Others will follow suit.

The Comet pioneered in the pure jet powered type and will continue in service with plane modifications indicated as necessary by the exhaustive investigation in the U.K. dealing with fatigue. The Boeing 707 will find an important place in this category; and finally a large proportion of the fleets serving long range services will be jet equipped.

It seems very likely that more effort will be expended in the future in the development of the bypass or ducted fan arrangement which will then find an important place as the best power plant for aircraft in certain fields of operation.

The potentialities of slow landing aircraft were first demonstrated in the Curtiss Tanager in 1930 and revived in the Pioneer, a similar type developed by Scottish Aviation at Prestwick, Scotland and the Helioplane in

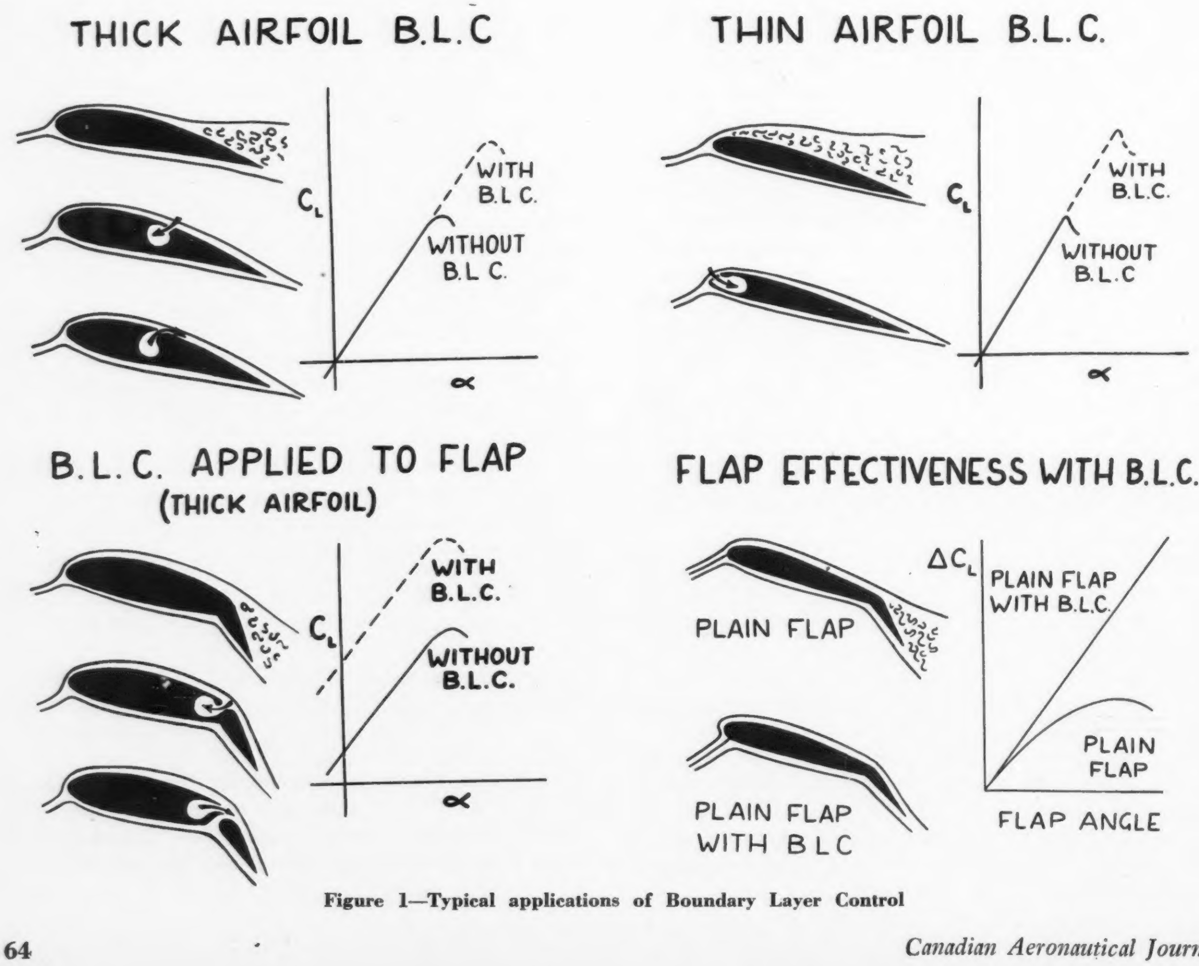


Figure 1—Typical applications of Boundary Layer Control

the U.S. In these instances, slots and flaps are used over a large proportion of the wing area.

I feel that the most important change aerodynamically in present type aircraft will be the use of boundary layer control (Figure 1). The potential for improvement in lift by the blowing type of lift augmentation is becoming well known and is proving particularly attractive because of the energy source available by the expedient of jet engine compressor bleed. The resulting reduction in stalling speed with improved control during approach fits in with our need for improving characteristics at the low end of the speed range. This scheme will find useful application in many types of aircraft other than air transports.

Resorting to boundary layer control for drag reduction, using the suction type, is finding many advocates. The jet engine bleed can also be used in this case. The engineering problems are more difficult of solution; including suction energy source, and maintenance of perforated or slotted surface during operation in a state free from roughness. However, one should stress the tremendous gains in speed and range theoretically attainable by the fully laminarized aircraft. Such rewards will be achieved once they are more generally recognized. The work of Dr. Lachmann of Handley Page as recently presented to the Royal Aeronautical Society[1] is outstanding and merits careful study. It would appear that the use of boundary layer control both for augmenting lift and decreasing drag will find an important place in our 650 mph aircraft of the future. I quote the following from Dr. Lachmann:

> "In the subsonic regime laminarization through boundary layer control and re-energization of the boundary layer remain the only fundamental aerodynamic possibilities to improve the economy of flight."

As aircraft are designed for speeds of over 500 miles an hour, wings of low thickness ratio and having sweepback angles appropriate for design speeds will be used.

2. Rotary wing aircraft

The helicopter is finding more and more favor because of its vertical rising, vertical descent and hovering capabilities. Present uses will be augmented by many others as certain troublesome problems are eliminated. Vibration is one of these difficulties. The local service airlines will use helicopters extensively when an efficient twin-engined rotary winged aircraft of 30 to 40 seat capacity is developed and when city center heliports are available. This latter is indeed a must because the inherently slower speed of the helicopter when compared even to the modest speed of a DC 3 will not permit its economical use if an airport limousine trip must be superimposed on the flying time. However, given landing areas in cities, the helicopter easily wins out for local service use.

The development of a suitable free turbine power unit will improve helicopter performance and there is considerable advantage to be derived from rotor tip, pressure jet drive. Noise, however, is a serious deterent.

To enhance the cruising speed limitations of the helicopter, the convertiplane concept is most intriguing. From probable top cruise speeds of the order of 150 mph for the helicopter, it appears that rotary wing aircraft combined with fixed wing components can achieve speeds of 250 or 300 mph or even more. There are penalties involved in weight and complications, but one inclines to the belief that these will be sufficiently reduced to assure a place of considerable importance for this type.

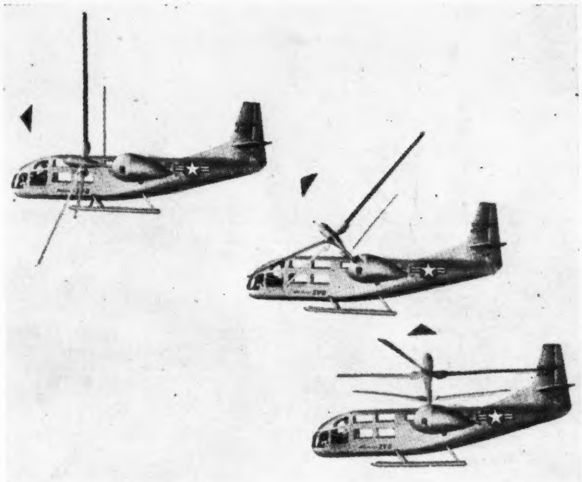


Figure 2—U.S. Army XV-3 Convertiplane

Several configurations are being developed including the 90 degrees rotatable rotor-to-propeller of Bell Aircraft (Figure 2) and the Fairey Rotodyne somewhat similar to the recently tested McDonnell. These have recourse to horizontal thrust with propellers driven

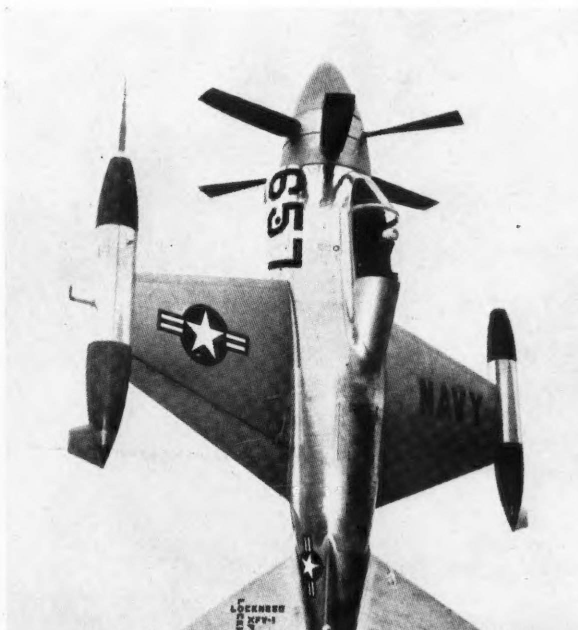


Figure 3—Lockheed XFV-1

either by piston or turbo-prop engines which fly the craft on stub wings, unloading the rotor when in horizontal flight. Jet engines could, of course, also be used. For vertical rising and descending, most of the power is used to drive a compressor which supplies energy to pressure jets on the rotor tips. Many other configurations for convertiplanes have been proposed and several are in prototype development. One feels sure an appropriate answer or answers will be forthcoming.

3. Direct thrust vertical risers

The tail sitters, such as the Convair and Lockheed, (Figure 3) have been flown and achieved conversion successfully many times. The prototypes designed for military uses are important in demonstrating both the practicability of vertical rising and decent using turbo-prop engines and as well the air conversion to horizontal flight and back to vertical. As complete dependance is placed on the power plant functioning properly during take-off and landing, obviously 100% reliability for the engine and propeller is essential to safe operation. Also, successful landing with the pilot in a semi-reclined position is difficult. However, the initial success of this difficult venture will stimulate developments that may eliminate present shortcomings. Many times civil aircraft developments get their initial boost from military undertakings.

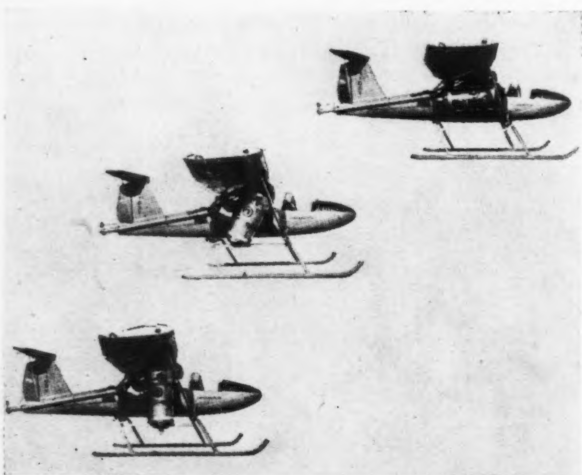


Figure 4—Bell VTOL

Another vertical riser configuration, also developed by Bell, is analogous to his 90 degree rotatable rotor-to-propeller convertiplane with a jet engine substituted for the rotor; i.e., the jet engine is rotated 90 degrees from the position for vertical rising to the position for horizontal flight (Figure 4). This has great promise, direct jet lift having been demonstrated by the Rolls-Royce "flying bedstead" (Figure 5). Probably, power plant reliability will be achieved through the multi-engine principle. These types of craft seem to call for many small power plants of very high thrust-weight ratios. Consideration might well be given to the small jet engine clusters advocated by Mr. Phil Taylor at an SAE conference last winter.

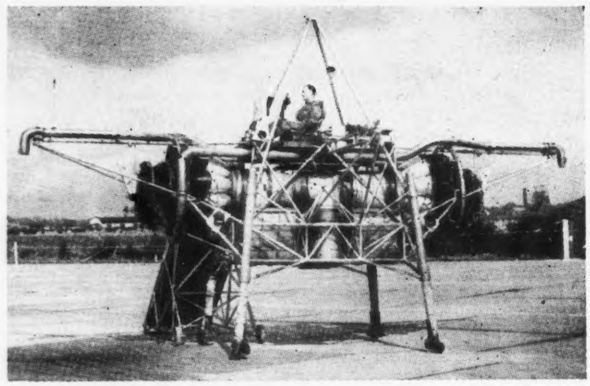


Figure 5—Rolls-Royce "Flying Bedstead"

For the type of direct thrust vertical riser here discussed, the bypass engine has considerable merit and will no doubt be used when developed. Better static thrust than the pure jet together with suitable efficiency at high speeds is indicated.

Other configurations for vertical risers are being studied such as those which divert the slipstream over a wing through 90 degrees by a retractable cascade of vanes or a so-called venetian blind unit. When the need for vertical rise and descent submitted as necessary in the first part of this paper under basic concepts is more widely recognized, one is confident that developments, useful in air transport and many other fields of aviation will be conceived and brought to successful issue. Possibly, the potentially efficient power plant-lift integration system using thrust for inducing flow over a lifting surface will be the answer.

Before leaving these stimulating considerations, mention should be made of the "flying platform" of Hiller Aircraft (Figure 5). One can conceive of many uses for such a vehicle both military and civil. It is too early to foretell whether the obvious hazards of such flying platforms when in use by the public can be overcome sufficiently to make them practicable. However, their simplicity and susceptibility to flight stability by recourse to instinctive body actions, is highly intriguing.

In closing this discussion on true vertical risers, I wish to state my belief that they will play an important part in aviation in the future in many fields of utilization.

4. Atomic power for air transportation

The difficulties in achieving proper shielding and suitable heat transfer mechanisms are tremendous. And yet, here again the rewards are very large. The bugaboo of long range operations disappear with such power plants. Shielding weights and other considerations point to use only in very large aircraft—possibly in the 150 ton category. The recent U.S. Navy announcement to proceed with the development of an atomic powered flying boat is noteworthy. Other basic concepts may arise, such as the aerial train idea with a remotely controlled propulsion unit and detachable gliders. This might reduce the shielding weight penalty.

Figure 6—Hiller "Flying Platform"

GROWTH OF AVIATION

Progress in all industries and, in fact, in most areas of human endeavour, follow the growth curve. Aviation and aircraft design is no exception. For each new enterprise, initial growth is slow both in overcoming the inertia of established ways and as well in researching, inventing and developing its own special principles and devices. Then there follows a steep part of the curve where development is rapid and steady, only to be followed eventually by a tapering off, gradually reaching a horizontal and then a declining portion of the curve. We in aviation are, I judge, scarcely halfway up the steep part of this curve. We have far to go, with more rapid development to be anticipated in the next 20 years than in the last.

The scientific method, started some 350 years ago with Sir Francis Bacon, has given us the tools of science by a compounding process, as science is like a regenerative furnace, feeding on itself. To this scientific knowledge and the great engineering techniques more recently developed, one even more powerful factor must be added, the unconquerable spirit of man. With sights set high on worthy objectives, nothing can stop achievement.

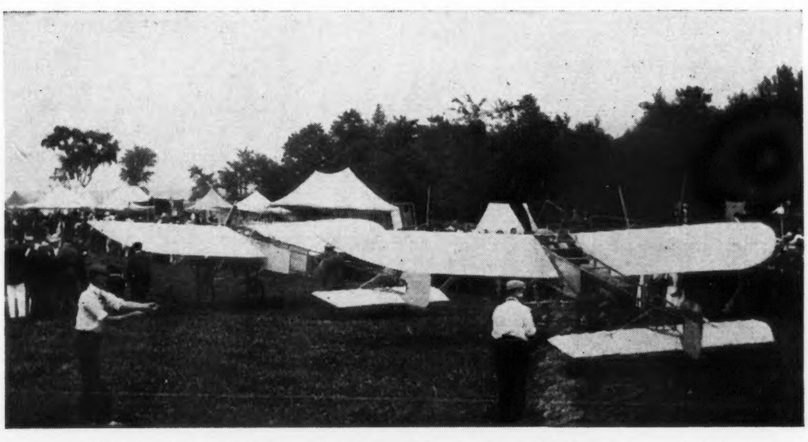
But more particularly, we must make these things available to the freedom loving side of the human family, to our western democratic societies.

I will close with a quotation from Arthur H. Compton.

> "Never has man had so real an opportunity to master his own destiny. With the new ideas of science, the new tools of technology, and the new views of man's place in nature which science has opened, we see ever more clearly how we can shape our world. May God grant us the vision of the possibilities of man which will challenge us to worthy use of these great new powers."

REFERENCE

(1) Lachmann, G. V.—"*Boundary Layer Control*",
Read before the R.Ae.S., 11th November, 1954;
ROYAL AERONAUTICAL SOCIETY JOURNAL MARCH 1955, PAGE 163.



The Lakeside Air Meet 1910: This is another picture of the air meet depicted on page 52 of the last issue. The Secretary wishes to acknowledge the letters received on this subject; in due course we hope to publish a brief account of the event.

THE TECHNICAL MANPOWER SITUATION

LETTER TO THE SECRETARY

I SHOULD like to make some comments on the letter by Mr. J. S. Brooks, published in the May edition of the Journal.

I have not met Mr. Brooks but am delighted to know that there is an engineer who can see the present situation and has the courage to publish his observations.

The expression "massive retaliation" of Mr. Brooks is similar to my own thoughts over the last few years concerning development and production by sheer weight of dollars and I prefer "massive retaliation" applied to the present situation, as seemingly man-hours are becoming more important than dollars, judging by the competition for new engineering graduates.

Not only does Mr. Brooks criticize existing conditions, but also proposes the remedy, which by actual experience in the past I have proved to be correct. I am sure that the number of engineers capable of accepting responsibility and producing results would be surprisingly large if the system were given a fair trial. Precise distribution of responsibilities to individuals requires also the proper delegation of the authority necessary to carry those responsibilities, plus the proper guidance, encouragement, patience and support from management. And of these requirements support is by no means the least. Design by committees may contain some factor of safety for individuals, on the basis that it is much more difficult to hang a committee than an individual, but development design, in this age of scientific advance, demands considerable individual courage in the application of technical convictions. This attribute of the good engineer can never be developed in the atmosphere of committees and good management understands this and makes final decisions accordingly instead of wandering through the minutes—the carefully written minutes?—of many committees.

Bright, new, shining graduates of Engineering still require experience before becoming engineers and this experience can only be obtained, possibly at some cost, from proper training under a fully informed management, leading to the delegation of authority by management and the acceptance of responsibility by the engineer. The new engineer, when considering his first position, should look for a management where this training can be obtained rather than at the size of the first check; just as the high school graduate should consider the long-term advantages of apprenticeship rather than the immediate and higher returns of the office boy.

These thoughts are only an elaboration of the remedial details set out by Mr. Brooks, to whom my congratulations for his clear presentation.

Ottawa — R. J. MOFFETT

SUSTAINING MEMBERS

NEW SUSTAINING MEMBER

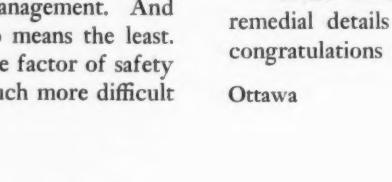
THE following Company has joined the Institute as a Sustaining Member

York Gears Limited, Toronto

NEWS

Computing Devices of Canada Ltd. has been appointed the Canadian distributor for Solatron Laboratory Instruments Ltd. of Thames Ditton, England who produce oscilloscopes and electronic laboratory test equipment. In addition this Company has been appointed Canadian distributor for the Allison Laboratories of Puente, California; Allison Laboratories produce continuously variable passive network audio frequency filters, clinical auditory test equipment, and sound level meters and analysers. Yet another agency taken by Computing Devices is for the complete line of transistors, semi-conductors and specialised components produced by Texas Instruments Inc. of Dallas.

Field Aviation Company Ltd. is bringing the Morane-Saulnier M-S 760 to Canada for demonstration purposes this summer. The M-S 760 is a twin jet, four-place, low-wing aircraft with maximum speed of over 400 m.p.h. and a range of over 1000 miles. It is pressurized and is reputed to have excellent handling characteristics.



The M-S 760

P.S.C. Applied Research Ltd. have recently concluded an agreement with Physical Measurements Co. Ltd. of Winnipeg whereby they will handle precision optical instruments to serve the geophysical, optical, mechanical and instrument engineering fields. P.S.C. Applied Research will set up repair and overhaul facilities for instruments designed and made by the Physical Measurements Co. and will eventually handle volume production and the Eastern sales of this equipment. The new line includes vernier microscopes, toolmakers microscopes, shadowgraphs, comparators, cathetometers, colorimeters, photo-microscopes, builders levels, compasses, surface alignment telecopes, instrument collimators, autocollimators, scales and reticules, and custom built optical and measurement instruments.

EDUCATION AND TRAINING†

THE EDUCATION AND TRAINING OF AN AERONAUTICAL ENGINEER

by Bernard Etkin *

University of Toronto

SUMMARY

The development of a fully qualified aeronautical engineer is shown to consist of two broad phases. The first phase, which corresponds roughly to the period of academic training, is that in which he learns the science fundamental to the profession. The second is that in which he develops the skills, and acquires the experience necessary to practise the art. The role played by the university is outlined, and exemplified by an analysis of the curriculum in Aeronautical Engineering at the University of Toronto. The responsibilities of the young graduate, and of his employer, in completing the second phase are discussed.

THE DISTINGUISHING FEATURES OF AERONAUTICAL ENGINEERING

In order to discuss in a meaningful manner a program of education and training for aeronautical engineering, it is necessary to establish first what a practising aeronautical engineer does, and what he needs to know in order to do it successfully.

Aeronautical engineers work in various organizations: in the aircraft industry, in research institutions, in government departments, in the armed forces, in civil airlines, in universities. The function which they are called upon to perform vary widely, and cover the whole range from non-technical engineering to pure science. These functions are sometimes indistiguishable from those performed by scientists and engineers in other fields. Some of the more important ones are listed in Table 1.

TABLE 1

FUNCTIONS PERFORMED BY AERONAUTICAL ENGINEERS

Aircraft Design	Wind Tunnel Testing
Aero Engine Design	Flight Testing
Propeller Design	Aircraft Maintenance
Structural Analysis	Aerodynamic Research
Aerodynamic Analysis	Structures Research
Aeroelastic Analysis	Establishment and Enforcement of Air Regulations
Operations Analysis	Administration
Structural Testing	

The performance of these functions involves a working practical knowledge of a large number of specialized subjects, some of which are listed in Table 2. For each of the functions in Table 1, a knowledge of at least some of the subjects in Table 2 are required.

TABLE 2

SPECIALIZED SUBJECTS INVOLVED IN THE PRACTICE OF AERONAUTICAL ENGINEERING

Aircraft Performance	Aircraft Electrical and Electronic Systems
Aircraft Stability and Control	Aircraft Instruments
Air-load Determination	Experimental and Research Techniques
Wing Theory	Aircraft Materials
Stress Analysis	Aircraft Fabrication and Production Methods
Aeroelasticity and Flutter	Servomechanisms and Automatic Controls
Rotary Wing Aerodynamics	Automatic Computing Devices
Propellers	
Reciprocating, Jet, and Rocket Engines	
Aircraft Hydraulic Systems	

Needless to say a penerating knowledge of all of these subjects is never found in the technical kit of any one engineer. A fully qualified aeronautical engineer will usually have a good working knowledge of one or two of them, and a nodding acquaintance with most of the others.

To recapitulate, Table 1 gives us an idea of what an aeronautical engineer does, and Table 2—of what he needs to know in order to do it. The question before us is "Exactly how is the engineer to acquire the knowledge and skill represented by Table 2?" Obviously he must acquire these through study and experience. The purpose of the remainder of this paper is to describe that process in some detail.

Before an engineer can profitably study any of the subjects of Table 2, he must be equipped with certain basic engineering and scientific knowledge. A sound appreciation of these fundamentals, especially of mathematics and physics, is indispensable. The subjects which I have chosen to place in this classification are listed in Table 3.

†Papers read at the Annual General Meeting of the C.A.I., Toronto, 19th May, 1955, before a panel on Aeronautical Education and Training.

*Associate Professor of Aeronautical Engineering.

TABLE 3
BASIC SUBJECTS INVOLVED IN THE PRACTICE OF AERONAUTICAL ENGINEERING

Mathematics	Fluid Mechanics and Aerodynamics
Physics	Theory of Measurement and Experimental Techniques
Mechanics	Heat Engines and Aircraft Propulsion
Electricity	Materials and Processes
Thermodynamics	Electronics
Optics	
Strength of Materials	
Theory of Structures	
Drawing	

In looking over this list of topics, we find that a knowledge of most of them is part of the equipment of engineers and scientists working in fields other than aeronautics. In fact there is only one item in the table which can be said to be the exclusive property of aeronautical engineers, and that is aerodynamics. However, there is another feature of the list that is characteristic of aeronautics, and that is the particular combination it contains. Apart altogether from the selection of the subject matter, there is still another point in which the program of study for aeronautical engineering differs from that for other branches of engineering such as civil and mechanical. That is the *advanced level* required in some of the subjects. An engineer who wants to understand why a supersonic wing performs as it does, or who wants to calculate the temperature distribution in it at higher supersonic speeds, or who wants to design the structure of that wing so that it will achieve a specified strength and stiffness, must have a knowledge of applied mathematics, aerodynamics, thermodynamics, elasticity, and theory of structures far beyond the normal requirements in other branches of engineering. This advanced level is due partly to the intrinsic complexity and difficulty of the problems involved, and partly to the high degree of refinement required in aeronautical engineering analysis. This refinement is a consequence of the stringent weight, performance and safety standards imposed by the nature of the airplane as a vehicle of transportation or as a weapon. As we all well know, the airplane does not leave much margin for error. Overdesigning to compensate for a lack of analysis may be feasible with bridges, punch presses, street cars, or steamships, but is too costly in performance to be accepted in aeronautics.

THE ROLE OF UNIVERSITY

What part should the universities play in preparing an engineer for this field? This is a very popular question, and discussing it seems to be a favourite sport of many practising engineers. Needless to say, a wide variety of opinions have been expressed in this connection, not all of them favourable to the university. What I have to say on the subject is my own opinion, and should not be taken as the official attitude of the University of Toronto nor of any unit within it.

The first thing the university does is to select its students. The high level of engineering and analytical ability required for this profession was previously referred to. In order to achieve this level the course of studies must inevitably be a stiff one, and only very good students will be able to complete it successfully. This makes it necessary to admit to a course in aeronautical engineering only those students who have considerable aptitude for this kind of work.

Unfortunately, no one has yet devised a suitable workable scheme for determining this aptitude in advance. We do the best we can at the University of Toronto using the results of the high school examinations as a yardstick. This is quite inadequate, however, as evidenced by a substantial failure rate in the first year. The entrance standard could be raised to reduce this failure rate, but this would undoubtedly also result in the exclusion of some students who would make first rate engineers. The reason for this is that high school examinations are no better a criterion for deciding who should be kept out than they are for deciding who should be admitted. They invariably result in the exclusion of some students who would succeed, and the admission of others who fail. The entrance problem is by no means solved. Perhaps in the future some of the techniques of aptitude testing may be employed to advantage to improve the selection process.

Let us turn now to a consideration of the curriculum with which the student is faced after he gets over the entrance hurdle. In Table 3 are listed the subjects which I have considered basic or fundamental. Clearly the education of the student must begin with these. Not until they have been more or less mastered can he go onto the subjects of Table 2, which represent the knowledge required in order to practise aeronautical engineering. For example, it is no use trying to teach airplane stress analysis until you have first taught the student some basic mechanics, strength of materials, and theory of structures. The curriculum must start out then with the basic subjects. In a typical four year course leading to a bachelor's degree, and I use the course at the University of Toronto for illustration, there is a total of about 3200 hours of instruction available for lecture and laboratories. By the time the indispensable fundamental material is covered it turns out that the lion's share of this time has been used up. Some of what is left must be devoted to non-technical courses in the humanities and social sciences. The engineer is after all a man and a social being first, an engineer second. His education cannot be considered complete unless it contains some broadening cultural elements, to help him to understand better the world in which he lives and works. This principle has been recognized for many years now by engineering educators, and the American Society for Engineering Education recommends an even larger non-technical content than we have included at Toronto.

It is very difficult to sort out exactly what proportion of the curriculum is devoted to the basic studies, corresponding to Table 3, and what proportion is given over to practical or applied studies corresponding to Table 2. The dividing lines are nebulous, and hard to locate. Roughly, in the University of Toronto curriculum, I have estimated that about 20 to 25% of the time goes into the practical work. This curriculum is shown in Tables 4 to 8, as it appeared in the 1954-55 Calendar. Some changes in the program have been made since, but these do not materially affect the picture presented here.

TABLE 4

FIRST YEAR CURRICULUM
COURSE IN AERONAUTICAL ENGINEERING AT THE
UNIVERSITY OF TORONTO

Subject	Hours per week Lecture	Laboratory
Algebra and Calculus	3	—
Analytical Geometry	2	—
Descriptive Geometry	1	—
Physics (Properties of Matter, Mechanics and Heat)	3	4
Applied Mechanics	2	—
Electricity	2	—
Chemistry	2	3
Drawing	—	4½
Surveying	½	1½
English	2	—
Physical Training	—	2
Total	32½	

TABLE 5

SECOND YEAR CURRICULUM
COURSE IN AERONAUTICAL ENGINEERING AT THE
UNIVERSITY OF TORONTO

Subject	Hours per week Lecture	Laboratory
Analytical Geometry of Space	1	—
Differential Calculus	3	—
Descriptive Geometry	1	—
Integral Calculus and Differential Equations	3	3
Dynamics	1	—
Light	1	4½
Magnetism and Electricity	2	—
Mechanics of Materials	2	1½
Theory of Machines	1½	—
Aeronautics	1	—
Drawing	—	3
Economics	2	—
Physical Training	—	2
Total	32½	

TABLE 6

THIRD YEAR CURRICULUM
COURSE IN AERONAUTICAL ENGINEERING AT THE
UNIVERSITY OF TORONTO

Subject	Hours per week Lecture	Laboratory
Differential Equations	1	1
Theory of Functions	1	1
Advanced Mechanics	1	—
Electrical Engineering	2	3
Heat Engines Theory	2	3
Machine Design	2	3
Fluid Mechanics	1	—
Applied Elasticity	1	—
Airplane Stress Analysis	1½	3
Airplane Design	—	1½
Modern World History	1	—
Political Science	1	—
Total	30	

TABLE 7

FOURTH YEAR CURRICULUM
COURSE IN AERONAUTICAL ENGINEERING AT THE
UNIVERSITY OF TORONTO

Subject	Hours per week Lecture	Laboratory
Differential Equations	2	—
Applied Aerodynamics	2	6
Gas Dynamics	2	—
Airplane Stress Analysis	2	3
Airplane Design	2	9
Aircraft Propulsion	1	—
Metallurgy	1	—
Thesis	—	—
Modern Political and Economic Trends	¾	—
Philosophy of Science	1	—
Profession of Engineering	¼	—
Total	32	

TABLE 8

TOTAL HOURS OF INSTRUCTION DURING 4 YEAR COURSE
(Based on 25 weeks per year)

Subject	Hours of Instruction		% of Total	
Mathematics	575		18.1	
Physics	625		19.7	
Mechanics		200		6.3
Electricity		288		9.1
Heat		62		1.9
Light		75		2.4
Strength of Materials, Elasticity, Structures	425		13.4	
Fluid Mechanics and Aerodynamics	300		9.4	
Heat Engines and Propulsion	150		4.7	
Design	438		13.8	
Drawing	187		5.9	
Humanities and Social Sciences	200		6.3	
Other	275		8.7	
Total	3175		100	

In summary, we see that up to the point of the bachelor's degree, a student receives about 3200 hours of instruction. By arbitrarily drawing dividing lines I have estimated that only some 650 to 800 hours of this time is on what can be called 'practical' work. It is quite apparent why such a student is not likely to be of great immediate value as a producer upon graduation. Of course, there is a wide variation from case to case. Some graduates have had aeronautical experience before coming to university; others have made the best use of their three summer vacations in getting valuable experience. Occasionally such individuals are immediately useful to their employers as practical engineers. A criticism commonly levelled at the university and at its graduates is based on this question of practical value. We may paraphrase the way it usually runs somewhat as follows. "Look at this fellow; here is a graduate of the university, and supposed to know something about aeronautical engineering, and he doesn't even know that the stressdynamic load on a toggleflap is proportional to the rate of strain flux times the woozel number. In fact, he doesn't even know what a toggleflap is!" Some-

times this criticism is justified, and it will be found that the student was in fact taught about toggleflaps, or told to read up on them for himself, and really should know something about them. On the other hand, it is often the case that a knowledge of toggleflaps is a very specialized piece of information indeed, required by only a small percentage of aeronautical engineers. There is a tremendous amount of material in this category, so much that it is obviously impossible to include very much of it in the period of formal education. There are at least two reasons why this is so. One is the limitation of time, and another is the limited knowledge of the teaching staff. I cannot conceive of a teaching staff of reasonable size in relation to that of the student body containing enough experts in all the diverse arts and skills of aeronautical engineering to make this possible. Even if these difficulties did not exist it is still questionable whether the university *should* do any of this kind of work. The nature of the topics involved is such that they can best be learned on the job—this is the role of experience. There is also to be considered the fact that it is just in the realm of these practical details that changes take place most rapidly. We might get a few good lectures or laboratory periods worked up on the subject of toggleflaps only to find that they are rapidly becoming obsolete because of some still newer development.

It is my opinion that the university should confine itself to those things which it can do better than the world outside; to instruct in those topics which are fundamental in nature, and an understanding of which is a common requirement for most of the fields of practice; to those subjects which a man is not likely to study on his own in later years if he fails to get the groundwork while he is a student. I consider that the university has succeeded in its task if its students have achieved three things while at school. The *first* is a solid grounding in a wide selection of fundamental subjects; the *second* is the ability to learn new things on his own, and confidence that he can do so; the *third* is the ability to think analytically and constructively. Of these three items, only the first is sensitive to the choice of subject matter contained in the curriculum, and I believe the curriculum I have shown you is basically satisfactory for this purpose. The other two items depend more upon the technique of teaching, and hence upon the pedagogical ability of the individual teacher, than on any other factor. Sometimes we teachers become so immersed in the subject matter that we forget this important aspect of our work. I believe that there is much room for improvement here, and that we should strive constantly to develop our teaching methods and techniques with the stated objectives in mind.

THE GRADUATE COURSE AT THE UNIVERSITY OF TORONTO

At the University of Toronto, post graduate instruction in this field is carried on by the Department of Aeronautical Engineering and Aerophysics of the School of Graduate Studies, in conjunction with the Institute of Aerophysics. Work is offered leading to the degree of M.A.Sc. and Ph.D. This portion of the instruction program is assuming more and more importance as time goes on. It will soon be the normal thing for students to continue for at least one year after obtaining the bachelor's degree. Aeronautical engineering is in effect becoming a five year course. It does not seem possible to give the student an adequate preparation in the subjects of Table 2 at an advanced level in less time than this. The graduate course, as noted below, is not restricted to students who have taken an undergraduate course in aeronautical engineering. Students who have graduated in any of several branches of engineering, physics or mathematics can be admitted. At the master's level, two options are available:

A. ***Aeronautical Engineering:—***

a) for candidates possessing a bachelor's degree in aeronautical engineering.

b) for candidates having degrees in other branches of engineering, and who desire to prepare themselves for aeronautical engineering. The course is arranged so that students in this category can make up deficiencies in their undergraduate preparation. It would normally take such individuals 2 years to obtain the M.A.Sc. in Aeronautical Engineering.

B. ***Aerophysics:—***

This option is available to candidates having a bachelor's degree in engineering, science, or mathematics. It is planned to prepare the student for basic research and development work in aerophysics.

To qualify for the M.A.Sc. degree in aeronautical engineering or aerophysics, the student must take, and pass successfully, at least three graduate courses, in addition to any undergraduate prerequisites which he must make up. He is also required to write a thesis based on the experimental or theoretical research to which he is assigned.

The courses of instruction offered by the Graduate Department are shown in Table 9.

TABLE 9

GRADUATE COURSES

1. Advanced Applied Aerodynamics—75 hours.
(experimental techniques; supersonic flow and shock waves; boundary layers; wing theory; airplane dynamics; aircraft propulsion)
2. Molecular Flow of Gases—50 hours.
(molecular basis of isentropic and non-isentropic flow; kinetic theory of boundary layers and shock transition; slip flow; mechanics of rarefied gases)
3. Wing and Airfoil Theory—25 hours.
(theory of wings and profiles in subsonic and supersonic flow)
4. Airplane Dynamics—25 hours.
(general equations of motion of a body in flight; stability and control of airplanes)
5. Experimental Methods—25 hours.
(Wind tunnels; shock tubes; optical methods; hot-wire anemometry)
6. Non-Stationary Supersonic Flows—25 hours.
(shock tube flows; interactions of shock waves; rarefaction waves and contact surfaces)
7. Stationary Supersonic Flows—25 hours.
(three dimensional flows and wave configurations; hodograph methods; three dimensional boundary layers)
8. Advanced Aircraft Propulsion—50 hours.

Following the master's degree, students who show marked ability for and an interest in research may proceed for an additional period of at least two years to qualify for the Ph.D. degree. The bulk of the research output of the Institute of Aerophysics is the work of these doctoral candidates.

ASSESSMENT OF GRADUATES

Employers of university graduates frequently have mistaken impressions of what these men know, and what they are capable of doing. I hope that the information given in the foregoing may help to remedy this situation to some extent. Making due allowance for the admittedly wide variations among individuals, and speaking of the "average" graduate, I would sum up the qualifications of men with the various degrees as follows:

a) A graduate with a B.A.Sc. in Aeronautical Engineering has academic ability greater than the average of engineering graduates. He knows a good deal of fundamentals, but is not able at this stage to apply this knowledge very effectively. He knows something about most of the specialties involved in aeronautical engineering, and more than a little about aerodynamics and structures. His training has been broad, and he is an excellent prospect for employment in any of the functions listed in Table 1. Although his immediate value as a producer may not, depending on the circumstances, be very great, he has a very high potential, which can be fully realized to the benefit of both himself and his employer if they co-operate effectively towards that end.

b) The graduate with an M.A.Sc. degree will, because of the selection factor, have on the average more academic ability than the bachelor. He will be found by his employer to be more mature, and more self-reliant. His knowledge of fundamentals and of the specialized subjects will be superior, and his ability to apply this knowledge to practical situations better than the man with the lower degree. The period of on-the-job training required should be less for men with this degree.

c) The Ph.D degree identifies a fully-trained scientist. This man will on the average be notable for his resourcefulness and self-reliance. After a relatively short familiarization period, he should be able to do effective work with little supervision. It is not usually important whether his Ph.D research has been specifically in the field of his new employment, since he will quickly learn, on his own initiative, whatever he needs to know.

I should like to emphasize that these remarks apply to the graduates *at the time* they obtain the respective degrees. I certainly do not imply that, say, ten years after graduation, there is *necessarily* any difference between a man with a B.A.Sc. and one with a Ph.D. There is far too much variation among individuals to justify any such assumption, which does not allow for experience and studying while on the job, nor for the nature of the job. It is quite possible that as an airplane designer the man with the lesser degree may ultimately outstrip in knowledge and ability his contemporary who has a higher degree. In research, however, this is less likely to happen. The advanced study which is represented by graduate degrees has been found to be essential for research workers.

THE GRADUATE'S RESPONSIBILITY

The new graduate must recognize the fact that he is not yet an aeronautical engineer. He has a good background of theory and fundamentals, but he also has the limitations already referred to. In the first months and years after graduation, it will be necessary for him to extend his theoretical knowledge in the direction of some specialty, and to absorb all the practical details and techniques required for the practice of his profession. Two activities are indispensible if these ends are to be achieved: continued study and experience. The responsibility for continued study rests squarely upon the shoulders of the man himself. The opportunity is *always* there. Sometimes there are courses of instruction made available by the firm or by a nearby educational institution. If there are none of these, there are always libraries full of books, journals, and reports containing literally millions of words relevant to his work and the subjects in which he is interested.

With respect to experience, the student has two main responsibilities. The first is to realize that during his summer vacations, and the first years after graduation, *learning* is far more important than *earning*. His choice of job at this period should be governed as far as possible by the value of the experience it offers. His second responsibility in this connection comes once he has taken a position. He should then make every effort to give his employer the best of which he is capable, even when his assignment appears to him to be low-brow and uninteresting. Such a willing attitude is sure to be appreciated, and the young man will find that a law of action and reaction is at work, which will result in his achieving the maximum professional growth that the job permits.

THE EMPLOYER'S RESPONSIBILITY

The employer's responsibility in continuing the training of a university graduate is very great, and I believe has been insuffiently appreciated by some employers of aeronautical engineers in the past. This responsibility begins with knowing the man. The employer must be aware of the general facts outlined in the section on "Assessment of graduates". He should, in addition, by careful interviewing, ascertain both the technical ability and personality traits of the individual with a view to matching the man to the job. In order to do this right, the employer must have competent personnel officers, well grounded in psychology and human relations.

Although I stated that the responsibility for continued study rests primarily on the embryo engineer himself, nevertheless it is unquestionably in the best interests of his employer to encourage and facilitate this activity in every reasonable way. This is one of the effective means of building morale. Failure to maintain good morale among young engineers can be calamitous. We must realize that in hiring an engineer, an employer is essentially buying brain-power. This is not the same as buying manual skill or muscle-power. The loss of efficiency and quality of output which are attendant on low morale can be disastrous in an individual who is working with his brain.

The most serious responsibility of the employer, however, rests in the matter of providing good experience. Failure to do this may have serious effects both on morale and ultimately on the quality of the engineering organization. As I see it, there are two main elements involved in this question of giving the new man the right in-plant training. One is job-assignment, and the second is supervision. The problem of job-assignment is readily solved by the planned training program. In such programs the new graduate is assigned to various departments and divisions of the organization for various lengths of time. This is a well recognized technique, of great value. It is in use now in at least one Canadian aircraft firm, and has been in successful operation for a great many years in other industries. The aims of this program are well summed up in a publication of Canadian Westinghouse: "To bridge the gap between your knowledge of principles, and their applications in industry, Westinghouse offers you the Graduate Student Training Course."

The other element to which I referred is supervision. This factor is present whether or not the graduate is in a training program. One of the decisive factors in the growth of the young engineer's skill, knowledge and ability is the desire of his supervisor to foster that growth. To put it in black and white terms, the supervisor or group leader can behave like an old fashioned plantation overseer, with no other purpose than to extract the maximum work in the minimum time, using the whip liberally in the process. Or he can be a sympathetic encouraging teacher, trying to see that the young man gets the most he can out of each new assignment—making his first months on the job a stimulating and challenging educational experience. These are extremes which no doubt are virtually never met in practice, yet they illustrate the point, which is this—every professional man has the responsibility to be a teacher. This responsibility is explicitly written into most professional codes of ethics. I appeal to those of you who are in a position to do so to see that this duty is discharged. When you give a man a job to do, fill him in on its context and background—show him where it fits into the overall project. Don't hand him a formula which you have derived and ask him merely to compute from it. Ask him first to check the derivation. Discuss the general problem, the assumptions you have made, and ask for his opinion. Encourage the men in your charge to learn and study, to read the literature, to think constructively and creatively about their own and related problems; commend them for good work when it merits it, and they in turn will develop at the maximum rate possible into fully qualified engineers. The learning process does not end when a student leaves school. Neither should the teaching. It is up to you practising engineers to carry on from the point where we leave off.

AN INDUSTRY APPRAISAL OF THE EDUCATION AND TRAINING OF TECHNICAL PERSONNEL

by Everett B. Schaefer *

Canadair Ltd.

THE suggested theme of this session, "Is there anything wrong with the education and training of aeronautical technical personnel in Canada?" is indeed broad in scope and certainly not one that can be answered with a simple yes or no, or without limitations and qualifications. This appraisal will therefore be confined to the university trained graduate, and even more specifically to the engineering school graduate.

NATURE OF THE PROBLEM

The aeronautical industry would without doubt agree on one sweeping answer to the propounded session question—yes, there is something wrong. There are not enough available technical personnel in Canada to meet our present and foreseeable future engineering staff requirements with the result that we are forced to recruit personnel from outside Canada. This situation has its unfortunate aspects from many points of view, and certainly the industry anticipated manpower requirements should have some bearing on the planning of technical personnel education programs. The same complaint, lack of technical personnel, applies in the U.S. according to a recent government study which indicated an overall shortage of over 70,000 engineers by the end of 1956. It can be surmised that similar figures for the Canadian picture are at least proportional, if indeed, on a percentage basis, not more heavily on the deficit side.

In illustration of the growth of manpower requirements over the past few years the following figures are quoted in the case of the Canadair Engineering Division.

Year	*Total Engineering Staff*	*% Change*
1950	180	—
1951	310	+ 72
1952	515	+ 66
1953	470	− 9
1954	730	+ 55
1955	850-900 (Goal)	(+ 16 to 23)

*Assistant Chief Engineer

These figures represent total engineering population, and in the case of the 1954 total of 730 those of graduate engineer calibre number 431 or 59%. Assuming a levelling out at 500 people of graduate engineering calibre and an average yearly turnover of 5%, the replacement requirement for new graduates would amount to 25 in this particular example. Another set of statistics indicates the diversification of types of engineering graduates in the present roster.

Type	*Percentage*
Mechanical	46.5
Civil	7.1
Aeronautical	22.8
Electrical	11.0
Chemical & Metallurgical	3.9
Other	8.6

It appears to me that an objective approach toward a concrete answer to the question before this panel would be to consider where the young graduate fails to meet the standards set by the industry engineering supervisors. Once having, in effect, set up some specifications by this method of criticism, the next logical step is to suggest means whereby the university and industry can individually and collectively work to improve the training of the student for his professional career.

PRESENT CRITICISMS

What then are the major criticisms of the new engineering graduate?

No. 1 He wants to be an analyst, not a designer. To most of them the thought of going on the board is abhorrent if not downright degrading. This is perhaps rather natural since in college most of the basic courses are of the analytical type, and those of laboratory character such as drafting, machine design etc. appear in a somewhat incidental light. His mental picture of an engineer then tends to be solely that of a desk man who pushes his slide rule through a set of mathematical equations and passes the results on to a small army of characters known as draftsmen and detailers.

No. 2 He appears to lack an appreciation of the value of thorough knowledge and application of the fundamental principles that apply to the field of the engineering sciences.

No. 3 He desires immediate specialization and appears to be somewhat unwilling to spend some time gathering experience before committing his career to one specialized avenue of endeavor.

No. 4 This last item deals with the factor of human relations. Our young graduate has little if any appreciation of the organization and community effort required in an engineering department. To be fair in this criticism we must consider his side of the story. Throughout his college life all his work and advancement has depended on his efforts alone, with the exception possibly of some laboratory classes. Also, from the lordly estate of college senior he is suddenly landed in the position of the lowest of the low in a mysterious group of hundreds or even thousands. He feels utterly lost, wonders if the company really knows who or what he is, and cannot see how he can possibly advance in position. The shock is a great one, and he has not been prepared for it.

No doubt individual supervisors would wish to add other items to this list or perhaps wish to emphasize the importance of one over another, but I believe those listed are salient points which generally apply.

SOME SUGGESTIONS

Industry does not expect the university to teach the practical experience factor for the obvious reasons, but it is believed that a closer cooperation between the university and industry can better prepare the young graduate for the impact of his first position in industry. Let us therefore now explore some of the means whereby university and industry can approach this problem.

The university instructors being in contact with the student throughout his higher schooling period are certainly the most important medium of information flow. For the teacher to impart the flavour of the industrial approach he must obviously have such information or experience at hand. The university and industry can do something about this aspect of the common problem.

1. Both can encourage university teaching staff members to take summer positions in industry. Industry can take the lead in this by informing the university authorities that such positions are open to their staff members. Industry must look upon this as an investment for the future, and not expect to receive immediate dollar value return from the hiring of such personnel. From the university point of view such an arrangement strengthens the staff knowledge and ultimately the overall value of the courses of study offered. It serves as a strengthening of the bond between the two leading to a better appreciation of each others problems.
2. A complementary approach from the other direction would be for engineers from industry to go to the university and deliver lectures illustrating the industry approach and solution to a particular current problem. Such periodic talks would be of interest to both the student and the professor and would foster the feeling that industry is interested in them and their work.
3. Another means of cementing the desired relationship between university and industry would be by meeting between staff members of each. Such meetings on a discussion basis, and with a working agenda for each should promote better mutual problem appreciation and lead to positive action programs.

Cooperative Courses

If we revert to a previous statement that industry does not expect the university to give the student practical experience in addition to the basic fundamental training, the thought of a cooperative type course immediately suggests itself. There are many potential advantages to such a planned course of study since it incorporates alternate periods of time in attendance at the university and in industry. For the student the blending of academic training and industrial experience in this manner is of twofold benefit. It gives him some insight into the methods of application of engineering principles in industry, and I suggest, indicates to him the immense value of the training in fundamentals he receives in university. A further advantage to both university and industry lies in the thought that the financial relief afforded by industry pay would open the benefits of university training to students who would not ordinarily be in a position to finance a full period of residence at the university. The cooperative scheme very directly cements the desirable liaison between university and industry, and is, I believe, worthy of serious consideration.

Post-Graduate Training

The rather general statement made at the beginning of this paper that all engineering graduates wish to be analysts and not designers requires some examination. Certainly some of them have a natural talent for analytical work while others have a greater aptitude for layout and detail design work. I do believe however that it is fair to state that in general the young graduate engineer tends to shy away from his first job offer that would put him on the board. This is unfortunate for I believe that some design experience or at least some familiarity with design office techniques and procedures is an excellent foundation of knowledge from which an engineer can direct his plans for specialization. Immediate specialization upon leaving the university can in the long run severely restrict the engineer's broad advancement possibilities. The university can exert some influence on the student regarding these factors, and I submit that studies of ways and means of passing on guidance and advice to the student in this matter while he is in university would be of great value.

In the matter of immediate specialization for the recent graduate, the industry must assume the major responsibility for the prevalence of such action. The aeronautical industry has been laggard in the matter of instituting training courses for the inexperienced graduate that would supplement his fundamental university training. It is a fairly common belief among engineering supervisors that it takes a new graduate a period of time approaching one year of training on the job before he reaches the point of productiveness. If this is generally true, then this first year in industry should be well planned to give the man a broader training than he would receive by confining his endeavours to one narrow aspect of the engineering vista. An on-the-job training program planning for rotation through several engineering departments, and instruction sessions with experienced supervisors during this first year would give the man some real knowledge of the various engineering activities thus helping him to decide in which direction his interest lies, and would enable a better evaluation to be made of his capabilities and aptitudes. Planned training schemes in industry, to my way of thinking, are a natural and desirable follow-up to university training.

CONCLUSION

In summing up this brief discussion on the question "Is there anything wrong with the education and training of aeronautical technical personnel in Canada?" I conclude that there are several things that are not done in the best manner to achieve the desirable standards. Foremost, there should be continuous and close cooperation between industry, who are, after all, partners in a common cause. Industry, on its part, has not generally fostered closer relations with the university, and again generally has not followed up university basic training with planned on-the-job training programs.

The Canadian Aeronautical Institute membership, including as it does representatives from all branches of the aeronautical industry and the university staffs, provides an excellent meeting ground for a discussion of this most important subject. The Institute as an independent professional society is in a favored position to stimulate and foster an objective program of cooperation between university and industry. It is to be hoped that this panel discussion is merely the first step in a C.A.I. long term program in this matter of education and training of aeronautical technical personnel in Canada. The key to improvement in this field will be found in complete cooperation and interchange of ideas between university and industry.

Chateau Laurier, Ottawa

JOINT I.A.S./C.A.I. MEETING

3rd and 4th November 1955

The March issue, No. 7, of the C.A.I. Log is out of print and no stocks are held at C.A.I. Headquarters. The Secretary would be grateful for the return of any unwanted copies which may still be available.

C.A.I. LOG

SECRETARY'S LETTER

THE big event of the month of course has been the Annual General Meeting of the Institute but I have also attended some Branch Annual General Meetings, which, in their own ways, were almost as interesting.

TORONTO

On the 3rd May I was in Toronto. I spent the morning at de Havilland, the afternoon at Avro and the evening at the Elms Golf Club where the Annual General Meeting of the Branch was held. Two years ago the I.A.S. Section held its Annual General Meeting at the same place and it was good to be back in familiar surroundings and to meet many of my old friends. My only regret was that time was short and I was unable to talk to as many people as I should have liked.

MONTREAL

The following week, on the 11th May, I visited Montreal. It was a brief visit; I drove down in the afternoon, attended the meeting in the evening and drove back to Ottawa afterwards.

I have always been worried about Annual General Meetings which begin with one Executive in office and end with another. There is always a doubt about which Executive runs the meeting, which Secretary records it and which Chairman declares the meeting adjourned. Mr. Schaefer, the retiring Chairman, managed it very neatly. He gave his report; Mr. Whiteman, the retiring Secretary gave his; Mr. Stapells, the retiring Vice-chairman gave the financial report–in the absence of Mr. Wier, the retiring Treasurer; and then Mr. Schaefer turned the whole thing over to A/V/M James, the new Chairman, who carried on from there, introducing the speaker and generally taking over the proceedings. It worked very smoothly and this procedure can be recommended for similar occasions, when the program is not too elaborate.

OTTAWA

The Ottawa Branch held its Annual General Meeting on the same evening as Montreal and unfortunately I could not be in both places at once. I hear that it was a very good meeting and I am sorry I missed it.

ADMINISTRATION OF 1955-56

On the 18th May, the day before the opening of the Annual General Meeting of the Institute, a meeting was held, attended by the members of the old and the new Councils. Another meeting of the new Council alone, was held in the afternoon of the 20th May, while the last session of the Annual General Meeting was in progress. These meetings were necessary, firstly to hand over the reins from the old to the new, and secondly, to decide how to meet the new problems introduced by the recent addition of Branches at Vancouver and Winnipeg.

In the past it has not been too inconvenient to hold Council meetings at intervals of about six weeks but since the Council now contains representatives of Vancouver and Winnipeg, and since at least one representative from each Branch must be present to form a quorum, such frequent meetings will not be possible in future.

The By-laws provide for an Executive Committee to direct the affairs of the Institute within the scope of the policies established by the Council and though such a Committee has existed in the past – comprising the Ottawa members of Council–it has not had very much to do, because the Council met frequently enough to handle the work itself. In 1955-56 this Executive Committee will be expanded to include Toronto and Montreal representatives and it will carry on the routine work, keeping all the Council members informed of its activities. The full Council will meet perhaps only three or four times in the year.

Now that the basic policies have been set by the old Council his procedure should work satisfactorily.

NEW BRANCHES

One of the chief functions of an Annual General Meeting is to provide opportunities for people to talk shop with friends and acquaintances whom they do not meet very often. My particular shop is the C.A.I. and I was very glad to be able to discuss the progress in Edmonton and Halifax with Mr. C. C. Young of Northwest Industries and Professor O. Cochkanoff of the Nova Scotia Technical College. I was glad to have these first hand reports which helped to confirm my hopes that we should have Branches in both these cities before the fall season is over.

ANNUAL GENERAL MEETING

THE Annual General Meeting of the C.A.I. was held on the 19th, 20th May in the Royal York Hotel, Toronto. It comprised a Business Meeting in the morning of the first day and the Annual Dinner in the evening, with four half-day technical sessions occupying the Thursday afternoon and all day on the Friday.

BUSINESS MEETING

The Business Meeting was attended by over 100 members. The proceedings opened with a brief address of welcome by Mr. I. M. Hamer, Chairman of the Toronto Branch in 1954-55, and the presentation of the President's Badge by Mr. R. F. Hunt on behalf of Mr. G. H. Dowty. The President then read the Annual Report of the Council, and the Chairmen of the Publications, Admissions and Finance Committees presented their reports. The meeting concluded with some discussion from the floor at which several useful and thoughtful comments were submitted. The reports of the Council and of the Committees are reproduced elsewhere in this issue.

Part of the Head Table: (l to r) Mr. G. R. McGregor, Dr. T. P. Wright, Principal Speaker, Mr. J. C. Floyd, thanking Dr. Wright for his address, Dr. J. J. Green, President C.A.I., and the Hon. J. A. D. McCurdy.

Dr. J. J. Green, retiring President, transfers the President's Badge to his successor, Mr. R. D. Richmond.

THE DINNER

Some 420 members and guests attended the Dinner. After the usual preliminaries the President announced the award of Honorary Fellowships to the following;

Mr. C. D. Howe
A/V/M E. W. Stedman
Capt. S. Paul Johnston
Mr. R. R. Dexter
Dr. A. M. Ballantyne

The Principal Speaker was Dr. T. P. Wright, Vice-President for Research, Cornell University and his subject was "Aircraft Design Possibilities of the Future"; his talk included a masterly summary of the progress of commercial aviation and a review of the vertical and steep gradient take-off and landing developments now taking place.

Dr. Wright's address, which appears on page 61 of this issue, was followed by the presentation of the McCurdy Award to Mr. M. W. MacLeod.

The proceedings were closed by the

introduction of Mr. R. D. Richmond, the new President.

After the Dinner Dr. Wright showed an N.A.C.A. film depicting some of the varieties of vertical and steep gradient technique which he had discussed in his address.

TECHNICAL SESSIONS

The technical sessions are reported upon individually as follows:—

Afternoon Session May 19th
Education and Training

Reported by N. W. Hayman

The activities of the first afternoon session under the vigorous Chairmanship of Mr. T. R. Loudon (de Havilland of Canada), included two papers, a panel discussion and a question-answer period all directed to exploring the question "Is there anything wrong with the education and training of aeronautical technical personnel in Canada?"

Education and Training Session: (l to r) Prof. B. Etkin (speaker), Mr. R. H. Guthrie, Mr. E. B. Schaefer (speaker), Mr. I. A. Gray, Prof. T. R. Loudon (Chairman), Prof. D. L. Mordell, Mr. J. A. Chamberlin, Mr. J. P. Francis.

The first paper "The Education and Training of an Aeronautical Engineer" was presented by Professor Bernard Etkin (University of Toronto). The paper described the functions performed by aeronautical engineers, the specialized subjects involved in these functions and the basic subjects required before the engineer is able to deal with the specialized subjects. Professor Etkin indicated the emphasis on fundamental subjects in the undergratuate aeronautical engineering course at the University of Toronto, showing that only 25% of the students' time during the four-year course is devoted to "practical" subjects. He considered that the role of the University was to provide the student with a solid grounding in fundamental subjects, the ability to learn new things on his own and the confidence that he can do so, and the ability to think analytically and constructively. The post-graduate program in aeronautical engineering at the University of Toronto was then described, followed by a comparative assessment of the capabilities of graduates equipped with the Bachelors', Masters' and Doctors' degrees. It was emphasized that these capabilities must be understood by industry to ensure proper placement of graduates. The graduate's responsibilities to himself and to industry are to recognize his limitatons upon graduation, to consider experience before money in selecting his first position and to continue studying beyond the day-to-day requirements of his job. In turn, Professor Etkin felt that the employer's responsibilities to the graduate include careful consideration of job assignments and mature supervision that will provide a suitable 'climate' for professional growth.

The second paper, presented by Mr. E. B. Schaefer (Canadair Ltd.), was entitled "An Industry Appraisal of the Education and Training of Technical Personnel". Mr. Schaefer discussed some of the criticisms heard in industry about young graduates, namely their desire for early specialization, their preference for analytical work instead of design, their lack of appreciation of the value of thorough knowledge of engineering fundamentals, and their relatively small appreciation of the organization and co-operative effort required in an engineering department. It was felt that these criticisms arise in part because industry has not maintained a close liaison with the universities and provided for suitable on-the-job training for students and graduates. A closer relationship could be established by having teaching staff employed in industry during the summers, even with a small dollar value return to the employer, by having engineers from industry teach part-time at the universities, and by discussions between university and industry staffs. These thoughts lead, naturally, to consideration of co-operation programs between universities and industry at the student level with alternate periods in school and in industry. In summary, the education of aeronautical technical personnel would be improved by closer liaison, co-operation and exchange of ideas between the universities and industry, and by industry providing suitable job training program to supplement the basic training given by the universities. Mr. Schaefer concluded with the hope that the C.A.I. could foster an objective and long-term program in the matter of education of aeronautical technical personnel in Canada.

At this point, the Chairman introduced the panel, asking each panel member in turn to comment on the papers and the question before the meeting. Mr. R. H. Guthrie (Canadian Pratt and Whitney) endorsed Mr. Schaefer's thoughts on university-industry co-operation, briefly mentioned the job training program in his firm, and asked that the technician not be forgotten in discussions on training of technical personnel. Professor D. L. Mordell (McGill University) put forward a strong case for generalized training in the universities in order to turn out individuals fit to become engineers rather than graduates trained in special subjects. Specialized subjects mentioned by Professor Etkin could be included as branches of basic subjects, and he indicated the trend to generalized engineering training at McGill University. Professor Mordell agreed with Professor Etkin and Mr. Schaefer on the role and responsibilities of the universities, industry and the graduate, in the matter of education.

Mr. J. P. Francis (Dominion Dept. of Labour) presented some very interesting statistics on aeronautical engineers in Canada. It was noted, for example, that 20% of the practising aeronautical engineers in Canada have post-graduate training, and only in the chemical engineering field is this percentage higher. Also, over 50% of the practising aeronautical engineers are engaged in research, design and development, i.e., product research and design as opposed to production, sales, etc., this being higher than in any other engineering field.

Mr. I. A. Gray, (Canadian Pacific Air Lines) discussed some of the difficulties encountered in training technicians and air engineers, and cited C.P.A.L.'s four-year program in this field. Mr. J. A. Chamberlin (Avro Aircraft Ltd.) stated that in his experience there was a very definite return in summer employmeent of university staff members. He felt that thorough basic training in mathematics, mechanics, electronics and mechanical design were essential, and that the mathematical training given to aeronautical engineering stdents should be more extensive, even at the expense of reduced study of stress and aerodynamics.

The final portion of the meeting was turned over to questions and comment from the floor. This provided a lively discussion on such topics as engineering qualifications, evening courses, the possible role of the C.A.I. in promoting improvement in aeronautical engineering education, in-plant training, and a pointed statement by Dr. G. N. Patterson, Head, Dept. of Aeronautical Engineering, University of Toronto, that more engineering graduates would ultimately appear if industry would not only support students by fellowships and scholarships, but also assist the universities financially to provide for increased staff and equipment.

The Chairman closed the meeting on the note that the C.A.I. should do all in its power to stimulate co-operation between the universities and industry which would lead to improved education of aeronautical technical personnel in Canada.

Morning Session May 20th
Manufacturing

Reported by N. W. Hayman

The session on Production, chaired by Mr. J. W. R. Drummond (Canadian Pratt and Whitney) included papers on jet engine production, aircraft tooling and titanium alloys for aircraft.

Mr. Earle K. Brownridge (Orenda Engines Ltd.) presented the first paper, his subject being "The Economic Production of Jet Engines in Canada". In his paper Mr. Brownridge gave an excellent insight into the overall problems faced by management in putting a jet engine into full production, and highlighted some of the major hurdles that were overcome in the Orenda engine program. The decision to produce the Orenda meant that more than sixty major subcontractors had to be found ,who could meet the demand, many of whom expanded their facilities and learned production techniques never before required. This sub-contracting program had to be tied into the main production program at Malton, during a period when the new Orenda production plant was being built and a production staff trained. The new plant was designed with flexibility in mind. Mr. Brownridge emphasized that this flexibility was the key to successful production, with more than 4000 design changes introduced on the Orenda engine during a three year period with no appreciable loss in production. Another major problem was to decide when a new engine design should be put into production, the decision resting between better engines at a late date, or an early flow of production engines with more design changes being introduced on the production line.

Despite the problems that had to be overcome, the Orenda engine reached peak production in only seven years. During this period the engine cost per pound of thrust was continually dropping, due to some very successful improvements in production methods and simplified design. Mr. Brownridge closed by outlining a timetable which would make it possible for a new jet engine design to move from drawing board to peak production in about five years.

Discussion on the paper revolved around such questions as manpower forecasts, origin of changes in engine design, co-operation between design and production, and production flow time on engine parts.

The next paper titled "Economy of Tooling" was given by Mr. R. J. Higman (Canadair Ltd.). He began his paper by discussing the position of aircraft manufacturers who in past years have been used to large-scale production of fairly conventional aircraft, involving large facilities, and substantial and expensive tooling that allowed relatively unskilled labor to turn out large numbers of parts to close tolerance limitations. Today, however, these same manufacturers are faced with relatively small orders for aircraft of advanced design and increased complexity. These conditions pose a real problem for the production engineer to provide economical and yet suitable tooling. Mr. Higman felt that a deliberate tooling philosophy must be developed to cater to the present conditions, and would require careful consideration of the relationship between tooling costs and size of program. One important criterion in providing a tool is that the cost of the tool plus production labor on a part must be less than the cost of making the part without a tool. If a tool is necessary its cost must be kept as low as possible by ingenious use of new materials, universal tooling methods, careful consideration of fabricating methods, and close liaison between production and design departments to standardize parts, or redesign where possible for economical tooling. Even the inspection department can contribute to reduced tooling costs by inspecting for satisfactory rather than 'perfect' parts, thus reducing the desire to produce tools that are unnecessarily accurate and elaborate. To be competitive, the aircraft industry must produce quality products at minimum cost. This can be accomplished by a down-to-earth and cost-concious approach to tooling in relation to the size of the production program.

At this point the Chairman thanked Mr. Higman and opened the meeting for questions from the floor. Interest during the subsequent discussion was centred on criteria for tooling costs, capital and chargeable costs for tooling, training and skills of shop personnel in relation to the nature of the tooling program.

The third paper by Mr. H. V. Kinsey (Dept. of Mines and Technical Surveys) entitled "Titanium Alloys for Aircraft", outlined the history and the recent rapid development of uses and production of titanium and its alloys.

The metal has definite application in the design of supersonic military aircraft due to its favourable strength-to-weight

E. K. Brownridge

R. J. Higman

H. V. Kinsey

ratio and its maintenance of strength characteristics at elevated temperatures. However, it cannot be considered as a mere substitute for aluminum or steel, but must be carefully considered as the most suitable structural material for any specific application. Factors justifying its consideration in design are the type of loading involved, stress distribution and temperatures encountered. Decisive factors in its actual use are the fabricating techniques required. Titanium alloys can be rolled, forged, extruded, formed and machined but proper techniques and equipment must be at hand. The handling of titanium places a premium on good shop equipment and top quality workmanship. More data is continually becoming available on titanium and its application, resulting in the growth of a more consistent and accurate body of knowledge on the subject. Mr. Kinsey mentioned the apparent significance of hydrogen in the behavior of titanium. Much work was still necessary to assess its real importance. Although titanium suffered from "wonder-metal" publicity several years ago, it is an extremely useful structural material for certain applications particularly in supersonic aircraft. Even now we are witnessing its very gradual invasion of the commercial aircraft field.

Discussion following the paper covered casting practice, comparison of newer high-strength steels with titanium, creep at room and elevated temperatures, and possibilities of cheaper production methods.

The meeting was adjourned after Mr. Drummond as Chairman moved a vote of thanks to the speakers.

One was left with the impression that the papers had been extremely well presented by three men who could, and did, speak authoritatively on their particular subjects.

Morning Session, May 20th
Aerodynamics

Reported by Dr. I. I. Glass

One of the distinguishing features of the second annual meeting was an entire session devoted to aerodynamics. It was well attended by members from industry, the armed forces, government research centres, and universities. Over fifty people were present. A much more intimate atmosphere prevailed than at a comparable larger meeting in the United States. The quality of the papers was excellent and on a par with those presented at similar sessions elsewhere.

Under the capable chairmanship of Dr. D. C. MacPhail, Assistant Director, N.A.E., four papers were presented during the three hour period, followed by interesting discussions. Dr. G. V. Bull gave a comprehensive and animated address on "Aerodynamic Studies in the CARDE Aeroballistics Range". He outlined the development of the equations of motion of bodies in flight and their solutions. The latter depend on test data obtained from wind tunnels or aeroballistic ranges.

The author described briefly the CARDE range and the techniques which are employed in firing missile models. The model is encased in a carrier or sabot and shot from a smooth-bore gun. The sabot is trapped by an armor plate barrier and the model goes down the 750 foot range. Along its flight path the model pierces paper cards which are stationed throughout the entire length of the range. The path history may be determined from the "imprints" left by the model on the "yawcards".

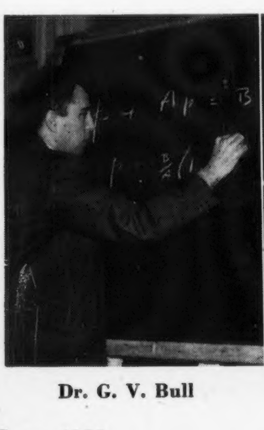
Typical experimental data were presented on model roll rate, terminal roll, roll moment coefficients due to differential wing deflection and damping, longitudinal aerodynamic characteristics, drag data, and resonant roll rates. The latter may lead to a serious condition which is known as resonant instability. In addition, the range may be utilized for aerodynamic testing throughout the subsonic, transonic, supersonic and hypersonic flow regimes by employing the same techniques in one facility.

Dr. Bull concluded that in general aerodynamic configurations yield very useful results, of about 5 percent accuracy, whereas aerodynamically uninteresting shapes often supply aerodynamically uninteresting data.

The second paper on "The Calculations of the Wave Drag of an Arbitrary Slender Body by Means of an Electrical Analogy Tank", by Mr. P. J. Pocock, was presented by the author in his usual lucid and interesting manner. The topic dealt with the similarity (noted by von Karman) between the equations dealing with supersonic wave drag of slender bodies and the induced drag of an equivalent lifting line in subsonic flow. This result is advantageous owing to the sizable existing literature which deals with the subsonic flow solutions.

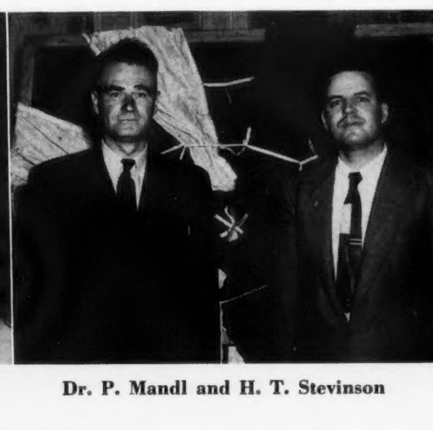
In particular, Malavard employed an electric analogy tank in order to obtain solutions of the lifting line equations without resorting to tedious and expensive numerical methods. The work at the NAE followed this method by employing a Malavard "wing calculator", having fifty equally spaced points along the body axis (or wing span) in order to calculate wave drag coefficients for symmetrical continuous bodies at zero incidence. A parbolic body of revolution and a body of given length and volume having minimum wave drag were used. The coefficients obtained from the theory and the analogy tank were in excellent agreement.

The third paper, "A Repeating Parachute", by H. T. Stevinson and P. Mandl, dealt with a new type of parachute developed by the NAE. This highly ingenious device is a self-controlling type of parachute that can open

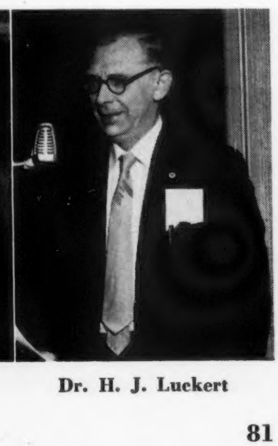


Dr. G. V. Bull

P. J. Pocock



Dr. P. Mandl and H. T. Stevinson



Dr. H. J. Luckert

and close itself repeatedly. The canopy behaves like a rotating wind-mill which winds up the shrouds, collapses, and reverses its direction of rotation in order to unwind again. This process is controlled by the pitch which is preset by the shroud lines.

The improvement in accuracy of supply dropping over a delayed conventional parachute may be as large as tenfold. This may be of vital importance in many precarious operations. The new parachute has been used successfully to accurately drop payloads in the range of 37 to 1000 pounds from altitudes of 1000 to 5000 feet.

The lecture was ably presented by Mr. H. T. Stevinson. The movies which were used to illustrate actual tests added considerably to a realistic understanding of this new type of parachute.

Dr. P. Mandl did the final mathematical analysis of this complex problem. The entire project conveyed the importance of selecting a team of both theoretical and experimental researchers in order to produce a workable solution to a very difficult problem.

The final paper on "Lift and Lift Distribution of Wings in Combination with Slender Bodies of Revolution", was presented by Dr. H. J. Luckert of Canadair. This was the author's first lecture in English and it was done very well.

The method of calculating lift distributions and lift coefficients of wing-body combinations of certain aspects ratio and body width to wing span ratio had previously been studied by many authors (Lennertz, Multhopp, Spreiter, Low and Stone). Each method is confined to a restricted range of applicability. The present analysis combines the methods of Multhopp and Weissinger to obtain a theory which is applicable over the entire range of aspect ratio and body diameter to wing span ratio. When applied to unswept wing-body combinations in symmetric subsonic flow, agreement is obtained with other known methods in the range where they apply. Satisfactory agreement between experiment and the present method is obtained for partial span flaps as well.

Questions from the audience throughout the session gave added stimulus to the meeting.

There is no doubt that the aerodynamic session was very successful. The authors and the CAI are to be congratulated for a very worthy effort.

Afternoon Session May 20th

Operations

Reported by P. G. Randell

The Chairman, Mr. D. N. Kendall, President of Photographic Survey Corporation, opened this afternoon session by introducing the speakers and outlining the program to follow, indicating that after each paper the meeting would be thrown open for general discussion from the floor.

R. E. Nethercut **J. C. Charleson** **J. Fleming**

The first paper, on "The Human Engineering of Aircraft Instruments and Controls", was given by Mr. R. E. Nethercut, Research Project Engineer, Minneapolis-Honeywell Regulator Company Limited.

Mr. Nethercut said that the stage in aeronautical development had been reached where the requirements now placed on the human pilot had increased so enormously in the past 30 years, despite the growth of automatic control, that in performance capabilities the pilot had become the limitation rather than the technical design of the aircraft.

One solution, he said, would be the completely automatic pilot, although the human pilot's capacities would still be required for certain special missions.

Mr. Nethercut went on to say that in designing a cockpit instrument panel it has to be decided in the job analysis of the pilot's task just what he needs to know before a start can be made on the actual design of the instruments. The final choice of layout, he said, should be based on the experimental evaluation of the operator's performance. Consequently, fewer and larger instruments would be used. Among these improved instruments would be altimeters and altitude indicators with a more pictorial display. Cathode ray tubes therefore, will play an increasingly important role.

Discussion period revealed interest generally in the trend toward larger instruments with pictorial displays and in particular the "moving-aircraft" type of Gyro Horizon, the increasing use of transistors, the advantages in lining up electronic instruments as opposed to the conventional type.

The Chairman thanked the speaker and said he was glad to hear that the human pilot was not obsolete even if a little obsolescent!

The paper on "The Helicopter, Present and Future" was presented by Mr. J. C. Charleson, representing Okanagan Helicopters Ltd., due to the inability of Mr. A. Stringer to attend the meeting.

Mr. Charleson drew attention to some of the more important uses of the helicopter, from the earlier days when it was used in agriculture for spraying purposes, to the more recent uses for transportation of men and materials and for exploratory work in mountainous and undeveloped areas. Great use of the helicopter has been made, he said, by the Topographical Division of the Department of Lands and Forests, and in the Aluminum Company's Kemano-Kitimat project.

Much time has been saved by the use of the helicopter for searching for minerals in hilly country where packhorse or foot-travel used to be the method employed.

Other uses to which these crafts have been put with great success are those of providing navigation aid to shipping in frozen Arctic waters, timber cruising, rodent control, seeding and fire-fighting, medical attention for people in almost inaccessible territory and transportation of mail from outlying airports to city centres.

Subsequent discussion brought to light one or two points, on limitations in flying at night and in strong headwinds. Auto-pilots are not normally used in helicopters, Mr. Charleson said, except that the military have had success with this for anti-sub work. Two pilots are used in helicopter operations due to the long hours during which it is possible to keep the machine operating.

The Chairman thanked Mr. Charleson

and said that as a pro-conservationist he felt rather deeply about the great loss of seals due to helicopter spotting operations.

Mr. J. Fleming, in his paper on "Aerial Survey Operations" mentioned the use of the magnetometer and scintillation counter in the operations of aerial survey in mineral prospecting. He spoke also of the means of establishing horizontal and vertical control for mapping, using the radar altimeter and Shoran equipment.

Mr. Fleming went on to name the various types of aircraft employed on low, medium and high altitude photography.

Aerial survey is being carried out by Sparton Air Services, Mr. Fleming said, over the whole of Canada including the Arctic—to within 400 miles of the geographic North pole, in the U.S.A., Africa and South America.

Due to the necessity of operating from remote temporary bases airstrips have had to be built, where none exist, to enable complete support by air. Mr. Fleming suggested that an apprenticeship scheme in connection with survey flying might be of advantage to Canadian aviation.

Mr. Fleming said that some 50% of their flying was done at around 30,000 feet in unpressurized aircraft, without auto-pilots, and that there were times when as much as 45 hours had been flown in six days.

The Chairman led the discussion by enquiring if film distortion had been experienced due to humidity. Interest was directed towards the use of colour film to separate different objects and to the scope of infra-red film in connection with forestry and soil studies. The effect of altitude flying on personnel was resolved in that, except for more heavily built persons no adverse effect was experienced by the crews.

Copies of Papers

Copies of the papers presented at the Annual General Meeting on the 19th/20th May are obtainable from the Secretary. Price 25c each.

THE McCURDY AWARD — 1954

THE McCurdy Award is presented annually to a resident of Canada for achievement in design, manufacture and maintenance related to aeronautics and is recognized as the highest honour which can be bestowed in Canada for work in the aeronautical technical field.

The 1954 winner was Mr. M. W. MacLeod of Trans-Canada Air Lines and the Award was presented to him by the Hon. J. A. D. McCurdy at the Annual Dinner of the Institute held in Toronto on the 19th May, 1955.

The Citation reads as follows:—

Mr. M. W. MacLeod of Trans-Canada Air Lines has been selected as the winner of the 1954 McCurdy Award for sustained contributions to the field of aviation, not only in the display of ingenuity in the solution of technical problems of considerable difficulty, but also because of his ability in passing on to many others some of his experience and his way of accomplishing these tasks. He is one of those who can think and plan ahead, who instill in others the confidence and the urge to strive for perfection in aircraft design, development and operation.

The C.A.I. believes that in selecting Mr. MacLeod for this Award, we are singling out someone whose accomplishments illustrate the very principles through which progress is achieved.

M. W. MacLeod with the McCurdy Award and Medallion

He has, for example, invented an ingenious brake disc slotting principle for the prevention of the warping of brake discs and this has been applied to many aircraft brakes in existence today. His development of a cowl flap hinge has not only materially benefited Canadian air transport operations, but has been welcomed by aircraft manufacturers and operators the world over because of the many hours of increased service life which it has provided. Mr. MacLeod is responsible for the cross-over exhaust system which has made such a remarkable decrease in the noise level in the cabins of North Star aircraft.

His ball and socket joint principle for exhaust systems is a classic in aeronautical design which has added to the safety and economy of engine exhaust system operation in Canada, the United States and the United Kingdom. He has made many improvements in pneumatic de-icers, emergency fuel systems, hydraulic and lubrication systems and has given to aviation countless other devices of use and value.

Perhaps less tangible, but none the less important, are his contributions to the instruction and helping of others with whom he has been associated. Literally hundreds of people in Canadian aviation owe much for their start in aviation and their success to his uinstinted assistance and training. Mr. MacLeod's current programme in simplification of job methods and personnel training will continue to compound his contributions to Canadian aviation for many years to come. Not content to look back and rest on past achievements, his devotion to the tasks that lie ahead seem to exemplify the very spirit and vigour of Canadian aviation.

ANNUAL REPORT

Of The Council

1954 - 55

SINCE the first General Meeting, which was held in Ottawa on the 25th May, 1954, the C.A.I. has experienced a year of rapid growth assuming more and more the responsibilities which a technical society should fulfil in Canadian aviation. It has established a headquarters organization and the three original Branches, in Montreal, Toronto and Ottawa, have settled down as vigorous and well-run groups. Furthermore, two new Branches have been formed, in Vancouver and Winnipeg, and there is every indication that in the coming year these new members of the family will render effective services to the objects of the Institute.

COUNCIL

The Council has met 10 times during the year. Before this Council took office, the ground had been prepared by the Interim Council under the Chairmanship of Group Captain Foottit; By-laws had been drafted and approved, and the general structure of the Institute had been planned. It was the duty of the 1954-55 Council to build on these foundations and to test the functioning of the By-laws in everyday operation.

The Council comprised two representatives from each Branch and it is indicative of their enthusiasm that attendance at all meetings has been excellent, although the meetings were all held in Ottawa on Saturdays.

Those members of the former Interim Council, who were not elected to the smaller Council of 1954-55, were invited to form an Advisory Committee and this Advisory Committee has attended all but two meetings of the Council. Their help has been invaluable.

In its efforts to develop new activities the Council has been handicapped to some extent by the need to establish existing activities on a sound footing. At this early stage in the life of the Institute the Council has been unable to delegate very much responsibility to Committees and has itself considered much of the detail of such matters as the finances of the Institute, publications, meeting programmes and the like. A great deal of its time has been taken by admissions, nearly 100 applications being considered at almost all of its meetings.

As a result of this attention to detail, the Council believes that it has set a general pattern which can be followed with confidence and that future Councils will be able to delegate greater responsibility to Committees—as indeed they must; representatives from such extreme Branches as Montreal and Vancouver cannot be expected to meet every six weeks or so.

HEADQUARTERS AND STAFF

In April 1954 the Interim Council had procured an office at 304 Laurier Avenue West, Ottawa; at that time there was no permanent staff but it was necessary to have some place to keep such records and equipment as the Institute then possessed. Group Captain Crossland, and later Mr. Oatway, acted as Honorary Secretary, using part-time stenographic help in the running of the office.

In June Mrs. Ross was appointed on a permanent basis to handle the clerical and stenographic work and in July Mr. Luttman, who had served previously as Secretary to the Interim Council, was appointed as Secretary of the Institute.

With this permanent staff, C.A.I. Headquarters was able to begin to give some service to the members and to the Branches; Branch records could be set up, based on accurate and up-to-date records at Headquarters, addressed envelopes could be supplied and, on three occasions, Headquarters has been able to help Branch Programs Committees in obtaining speakers. Furthermore membership cards have been sent to all members, and Certificates of Membership to all those entitled to them.

The work at Headquarters had increased to such an extent during the year that it became evident toward the end of March that additional staff must be taken on. Larger accommodation was obviously necessary and the Council therefore decided not to renew the lease on the existing office, which was due to expire on the 15th April; the Secretary was instructed to seek more suitable premises. It was eventually decided to transfer the Headquarters into the Commonwealth Building, a big new office block which is still unfinished and will not be available until late June; 525 sq. ft. of space in that building have been tentatively reserved for us. This space is nearly double that of the old office and the Council, considering this to leave little room for further expansion, has expressed a preference for about 700 sq. ft. if the internal partitioning of the building can be so arranged; a good deal depends on the manner in which the remainder of the space in the building is let.

In the meantime, since the 15th April and pending the availability of space in the new building, C.A.I. Headquarters is housed in a small office at 49 Metcalfe Street, which was available on a month to month basis. Until the final transfer to the Commonwealth Building, the old mailing address at 304 Laurier Avenue is being retained by special arrangement with the postal authorities.

At the beginning of May a Miss Grant was taken on as a junior typist. She will be able to relieve Mrs. Ross of filing, copy typing, etc. and with her help it should be possible to avoid the repeated calls on outside typing assistance which have been necessary ever since last September. In fact, the typing load has been so heavy that Mr. Luttman himself has had to handle much of the other clerical work—the addressograph machine, the duplicator, etc.—and the additional clerical help will enable him to devote more time to his proper duties in future.

With the advent of the Canadian Aeronautical Journal, to which reference is made later in this report, it may well be found necessary to appoint a full-time editor in the near future; this appointment has not yet been considered but it was borne in mind in selecting the new office accommodation.

INSTITUTE MEETINGS

At the meeting in Ottawa in May 1954, Mr. Dexter, Secretary of the I.A.S., suggested that a joint I.A.S./C.A.I. meeting should be arranged and the Council was quick to take him at his word. Accordingly, as soon as Mr. Luttman had taken up his appointment as Secretary,

he visited New York to find out how such a meeting could be arranged. It was decided that the meeting should be held in Montreal in October—it should be noted that this was a fairly daring decision at that stage in the Institute's development—and the Montreal Branch Executive was asked to make the physical arrangements. This they did admirably under the leadership of Mr. Stapells, their Vice-Chairman. The I.A.S. generously undertook to handle all the printing of notices, lapel cards, dinner tickets and so forth—a considerable item of expense—and they provided four speakers. There were five Canadian speakers.

The meeting was an outstanding success and was very well attended both from Canada and from the United States. It ranks as the Institute's first major contribution and, under I.A.S. guidance, it afforded a useful lesson to our fledgling organization.

This present meeting, our second General Meeting, associated as it is with four technical sessions, is our first solo. A very promising program had been prepared and this time the Toronto Branch Executive has handled the physical arrangements. It is too early yet to congratulate ourselves on a happy landing, but we are hopeful.

PUBLICATIONS

The Publications Committee, composed entirely of Ottawa members, namely Group Captain Foottit, Mr. Oatway and Mr. Lukasiewicz, has issued a monthly publication beginning in September. The original publication, the C.A.I. Log, was produced by the offset process and contained 25 to 30 pages monthly, covering one or two technical papers and news of the Institute's activities. It was supplied to all members and served a useful purpose in keeping the members in touch with the Institute and its affairs.

In April the Log was superseded by a printed Journal, the Canadian Aeronautical Journal. The first issue encountered a number of set-backs and did not appear until April had nearly gone. However, though it is still young and though all concerned with its production have a lot to learn, the Canadian Aeronautical Journal is full of promise and the Council believes that it has made the right decision in embarking upon this ambitious project. The C.A.I. will never amount to anything unless it can produce a creditable publication.

The report of the Publications Committee is attached as an Appendix to this report.

ADMISSIONS

In the early spring of 1954 when it was decided to go ahead with the formation of the Institute, the Interim Council hoped that it might be possible to end the first year of operation with 650 members. In fact, the first year has ended with nearly 1,100 members and applications for membership are still flowing in.

The qualifications for the various grades, as set out in the By-laws, follow I.A.S. practice fairly closely but it is impossible in such specifications to cover every set of circumstances to be encountered in practice. There are many borderline cases which must be decided by interpretation of the spirit of the By-laws rather than by the letter. To achieve some uniformity of interpretation the Regulations provide for the Admissions Committee to be representative of all Branches. In practice this has proved to be rather an unwieldy arrangement; it is fairly sure but very slow. Its ponderous machinery has been sorely taxed by the large numbers of applications which it has had to deal with but the greatest credit is due to this Committee, comprising G/C Crossland of Ottawa, Professor Loudon of Toronto and Mr. Higgins of Montreal, for the relentless manner in which it has tackled the job. The Council found that it could place considerable reliance on the recommendations of the Committee and it is believed that very few mistakes in grading have been made. The report of the Admissions Committee is attached as an Appendix to this report.

ELECTION OF FELLOWS

The By-laws require that a Fellow shall have been an Associate Fellow for at least one year; accordingly there could be no Fellows during the first year of the life of the Institute. However, the Council has now elected the following Fellows from those Associate Fellows who were admitted to the Institute before the 25th May, 1954 the date of the General Meeting when this Council took office:

A/C A. A. G. Corbet
G/C C. W. Crossland
Mr. W. K. Ebel
Mr. J. C. Floyd
G/C H. R. Foottit
Dr. J. J. Green
Mr. E. H. Higgins
Mr. R. D. Hiscocks
Mr. W. D. Hunter
Mr. H. C. Luttman
Dr. D. C. MacPhail
Mr. J. L. Orr
Dr. G. N. Patterson
Mr. H. S. Rees
Mr. R. D. Richmond
Mr. E. B. Schaefer
Mr. T. E. Stephenson
A/C G. G. Truscott

HONORARY FELLOWS

The Council has appointed six Honorary Fellows. The announcement of one of these, Mr. G. H. Dowty, was made at the Dinner held in Montreal on the 14th October. The other five are [a]:—

Mr. C. D. Howe
A/V/M E. W. Stedman
Capt. S. Paul Johnston
Mr. R. R. Dexter
Dr. A. M. Ballantyne

It is with deep regret that we must record the deaths of Mr. J. A. Wilson and Dr. W. R. Turnbull, Honorary Fellows of the Institute. The Council has proposed that to commemorate Dr. Turnbull's important early work, particularly on variable-pitch propellers, a "W. Rupert Turnbull Lecture" should be established, to be delivered annually at a meeting of the Institute; the Lecture will carry a $150.00 honorarium and will be given alternately by Canadian and foreign speakers.

FINANCE

The Finance Committee, composed of members from Montreal, namely Mr. Richmond, Mr. Guthrie and Mr. Ross, have had a difficult task in guiding the Institute through its first year, when no one could foresee what the income and cost of running this new venture were likely to be. However, as will be seen from the financial statement, they have succeeded in achieving a small surplus at the end of the year and, perhaps more important, they have established a reputation for careful and sound budgetting which is important if the Institute is to retain the support of its Sustaining Members.

Forty-seven companies, as Sustaining Members, have generously carried the Institute through the year. Their support was an act of faith in the ability of the Institute to render a service to Canadian aviation and there are indications that they believe that their faith has been justified and that they will support the Institute even more strongly in the coming year.

In considering the future support from Sustaining Members the Finance Committee consulted a group of representatives from the industry. This Industrial Sub-committee consisted of Mr. Reynolds of Bristol, Mr. Tooley of Canadair, Mr. Wood of T.C.A. and Mr. Wells of Spartan. The Council would like to express its thanks to these gentlemen for the time and helpful advice which they have given to the Institute.

The report of the Finance Committee is attached as an Appendix to this report.

[a]These names were announced at the Annual Dinner on the 19th May.

BRANCHES

The three original Branches, in Toronto, Montreal and Ottawa, have had a successful year and have been energetically led by their Executive Committees.

The Toronto Branch has held 7 technical meetings, all of which have been very well attended. The membership of this Branch has now exceeded 400, entitling it to an additional representative on the Council.

The Montreal Branch has accomplished the difficult feat of uniting into one organization the former Institute of Aircraft Technicians and the Montreal Section of the I.A.S. It has held 6 meetings during the year, in addition to the I.A.S./C.A.I. meeting last October, and now has 330 members.

The Ottawa Branch now has about 175 members; this is perhaps a disappointing increase on the membership of 130 of the former Ottawa Aeronautical Society. It has held 6 technical meetings, with an average attendance of about 70 members each.

The Vancouver Branch, formed in January, has held two technical meetings, which is very creditable when one considers that at this stage in its development, a good deal of time must necessarily be devoted to organizational affairs. The membership in Vancouver now exceeds 60.

The Winnipeg Branch was formed only in April. Its membership already exceeds 35 and, when the season starts in the fall, the membership can confidently be expected to increase considerably.

Embryo or "interim" organizations exist in Edmonton, Halifax and Calgary and there is a good possibility that new Branches will be formed in these three cities before the end of the coming year. In the emergence of these new Branches the hopes of the founders of the C.A.I. are being fulfilled and the Institute is developing into a truly Canadian organization stretching right across the country.

NEW COUNCIL

The Branches have had their elections and appointed their Officers for the coming year. The Council met with the new Councillors on the 18th May, and the members of the new Council elected a President and Vice-President from among their number. The new Council is accordingly constituted as follows:—

President: Mr. R. D. Richmond, (Montreal); *Vice-President*: Mr. T. E. Stephenson, (Ottawa); *Past-President*: Dr. J. J. Green, (Ottawa);

Councillors: Mr. C. J. Luby, (Toronto); Mr. W. D. Hunter, (Toronto); Mr. J. C. Floyd, (Toronto); Mr. E. B. Schaefer, (Montreal); Mr. J. Bertalino, (Vancouver); Mr. T. W. Siers, (Vancouver); Mr. R. C. Guest, (Winnipeg); Mr. D. A. Newey, (Winnipeg).

THE FUTURE

The future lies in the hands of other Councils, though the retiring Council has of course made certain plans for the work of the coming year. These include a development of Student activities, associated at first with the Toronto Branch and the University of Toronto, and the inauguration of a study of the education and training of aeronautical technical personnel in Canada to determine if possible where the weaknesses lie and to recommend corrective measures to industry and to the educational authorities.

In the work of the past year, experience has been gained which will enable the Council to make certain recommendations to its successors. Progress has been made and it appears that the prospects of the C.A.I. are full of promise. A little has been done; there is much more to do.

Report of the Publications Committee for the year 1954-55

After seven issues of the C.A.I. Log, from September 1954 to March 1955, this offset-printed publication was replaced by a properly printed Canadian Aeronautical Journal. There have been three issues of the Journal, April, May and June, during the 1954-55 lecture season. There will be 10 issues printed during the 1955-56 season, commencing in September. In other words, there will be no Journal printed during July and August this year.

While the C.A.I. Log averaged about $300 per month cost, from our limited experience with the Journal the cost per issue, neglecting advertising revenue, is about $800. To partially make up this differential it was necessary for the Publications Committee to recommend to the Council that each member be charged an additional fee of $2.00. This was accepted, and all members paid this with their 1955-56 membership subscriptions. It is hoped that increased advertising revenue will cover most of the cost of the next ten issues of the Journal.

Regardless of cost, however, the Committee feels that the objects of the Institute, related to the advancement of aeronautics, can never really be achieved unless we have a Journal to exchange the ideas that are so vital to progress. The more informal section of the Journal serves to knit the scattered membership together. Consequently the value of the Journal cannot be measured in dollars and cents alone.

Early this year the Council accepted the Committee's recommendation that the Journal should contain advertising. This will be limited to the front and back of the Journal, and not distributed through the text. It was considered that advertising is a service to members as well as to advertisers. And this applies to Sustaining Members, as well as others. For Sustaining Members it is an additional service that they buy and pay for at the regular rates.

The biggest single difficulty the Committee has faced during the last year is the shortage of articles. It is confidently hoped that this will be overcome during the next year through the cooperation of all members.

Wih Council approval, a fourth member, F/L W. M. McLeish, was added to the present Committee of G/C H. R. Foottit, J. Lukasciewitz and H. C. Oatway. This was done to ensure a better representation at each meeting, since it is difficult for all members to be present at all meetings. Furthermore, the Council has approved establishing an Editorial Board of some 12 members. These members will serve for a set period, and will be selected by the Publications Committee on the basis of specialist knowledge and geographical location. They will help edit articles received, and stimulate the flow of new material. It is hoped to get the Board selected during the coming summer.

The Committee recognizes the large amount of work that the C.A.I. Secretary, Mr. Luttman, has to devote to the Journal. As well as writing a lot of the text, and serving as the link between the Committee and the printer, he has to do all the last minute chores to get the Journal out on time. A full time editor will undoubtedly be required in the future as the Journal grows.

Report of the Admissions Committee for the year 1954-55

COMPOSITION

The Admissions Committee is established by C.A.I. Regulation No. 11. It is composed of the Chairmen of the Branch Membership Committees, each of whom is nominated by the Chairman of his Branch. The Chairman of the Admissions Committee is appointed by the President.

DUTIES

The duties of the Admissions Committee are prescribed in Regulation No. 8. Briefly, they are to review all applications for Admission, or for transfer from one grade of membership to another, and to submit recommendations regarding such applications to the Council. There is one exception to this rule: transfers to the grade of Fellow are not reviewed by the Committee, election to this grade being only by nomination by the members of the Council or by any four Fellows of the Institute.

MEMBERSHIP

The members of the Admissions Committee for 1954-55 are:

G/C C. W. Crossland (Ottawa) Chairman
Prof. T. R. Loudon (Toronto)
Mr. E. H. Higgins (Montreal)

REQUIREMENTS FOR ADMISSION

The requirements for admission are set out in Article 7 of the By-laws of the C.A.I. Since it is not possible to state exact specifications to fit each individual case, they must be written so as to allow reasonable flexibility of interpretation. For example, to be admitted to the grade of Member, an applicant must have "acquired a recognized standing in engineering, design, research, manufacture, instruction, test flying, etc." How can one define "recognized standing"? A person's standing in a community is a reflection of the opinions of those with whom he comes in contact. In interpreting this clause, the Committee tries to assess the merits of an applicant's work in his field, and usually receives useful guidance from the recommendations and remarks given by the applicant's references. The references are asked to give their opinion of an applicant's general reputation among specialists in his field, to describe work performed by the applicant that would qualify him, and to recommend the highest grade for which the applicant is technically qualified.

Not unnaturally, some confusion has arisen between grades of membership in the C.A.I. and other organizations. A few members have inquired why they had been admitted to the grade of Member, when they were already Associate Fellows in the Royal Aeronautical Society. The grades of membership of the C.A.I. are more closely paralled to those of the I.A.S. than of the R.Ae.S. The grade of Associate Fellow in the R.Ae.S. covers a much wider scope than the same grade in the C.A.I., and, similarly, the grade of Member in the C.A.I. covers a much wider scope than the grade of Associate in the R.Ae.S. As a result, many applicants who hold the grade of Associate Fellow in the R.Ae.S. have been admitted to the grade of Member.

TABLE I.

Grade	At 15 May 54	Admissions 15 May 54 to 18 May 55	Attrition	Total 18 May 55
Assoc. Fellow	76	94	1	169
Member	191	377	5	563
Associate	9	43	4	48
Tech. Member	102	188	14	276
Technician	5	16	1	20
Student	—	27	—	27
TOTAL		745		

PROCEDURE

In the first few months after the formation of the C.A.I. the number of applicants was such that in most cases it was not practicable to consult the references named by applicants. To aid in grading applicants, Branch Admissions Committees were formed in Ottawa, Toronto and Montreal, and each application was reviewed by the Branch Committee, in the area in which the applicant resided, before being reviewed by the main Admissions Committee. Applicants from other areas were reviewed by the Ottawa Branch Committee. The task was simplified by the fact that most of those who joined in the first few months were members of the R.Ae.S., the I.A.S., or the I.A.T., and they were well known to the members of the Branch Committees.

Later on, with the appointment of a permanent Secretary, it became feasible to consult references, and, with the beginning of the new fiscal year, the Branch Committees are no longer being consulted, except in special cases. References are being obtained in all cases. Since applications cannot be considered until the references have been received, applicants are advised to ensure that they are returned promptly.

The procedure for admitting a member is too involved to trace through its various steps in this report. It consumes considerable time and effort, but it is designed to ensure that applicants are graded as fairly and uniformly as possible. However, the Committee recognizes that errors and anomalies are inevitable. A few members have expressed dissatisfaction with the grade of membership awarded, and some have given additional information to support their case. All such requests for reconsideration have been carefully reviewed—in most cases by both the Branch Committee and the Admissions Committee. The Committee has also recommended re-grading of a few members on their own initiative.

A member may apply for transfer if he can produce evidence of qualifications for a higher grade or if he has accumulated sufficient additional experience since being admitted to meet the requirements stated in the By-laws.

MEMBERS ADMITTED

The total membership has been announced from time to time in the Log. The latest figures are given in Table 1.

The total membership, including Fellows and Honorary Fellows was 389 at the time of the first annual meeting and is 1113 now, a net increase of 724. There are approximately 70 applications being processed.

The rate of growth of the C.A.I. in its first year of operation has exceeded all expectations. Applications are still coming in and it is especially encouraging to note that the great majority of those applying in recent months have not been members of any other aeronautical organization. This is a clear indication that the C.A.I. is fulfilling a long-felt need. There is a job to be done and it is up to us to do it.

Report of the Finance Committee for the fiscal year 1954-55

GENERAL

During the first year of operation the Council was faced with many problems, not the least of which was the governing of its finances. Prior to last May the Interim Council undertook to predict a budget for 1954 at a time when there were very few members and no real precedent to refer to for probable income or expenditures.

This budget proved to be a sound basis from which to administer the funds of the Institute. One area however in which it was soon found to be misleading was in the estimated number of members. Due to the phenomenal growth of the organization it was necessary to revise the original budget to cater for an increase of approximately 70% in the membership contemplated a year ago.

INCOME

Income was received from several sources. The Royal Aeronautical Society, the Institute of the Aeronautical Sciences, the Institute of Aircraft Technicians, and the Engineering Institute of Canada provided grants totalling $2,300.00 in accordance with their generous agreement to assist in the establishment of the Canadian Aeronautical Institute. Membership dues and entrance fees accounted for $4,857.00.

The Annual General Meeting in Ottawa and the joint I.A.S.-C.A.I. meeting in Montreal together showed a surplus of $913.17. As anticipated, a major portion of our income was derived from Sustaining Members' dues. A total of 47 companies contributed $10,800.00 to the Institute during this first year, which was an encouraging demonstration of their confidence in the organization.

EXPENDITURES

The major item of expense was due to the establishment, operation and maintenance of the headquarters facility and staff, and the general administration of the membership. This function accounted for $11,707.92; $2,191.27 is attributed to the publication of the Log, and $1,106.00 was refunded to the Branches for their operation.

INDUSTRIAL SUB-COMMITTEE

As a result of the Industry's interest, the President directed the Finance Committee to organize an advisory panel consisting of representatives from industry to provide general consultation on financial matters, and specifically to assist in forecasting the income that might be expected from Sustaining Members in 1955. The response to our request was most gratifying and an Industrial Sub-Committee was formed in October 1954, made up of financial representatives from Bristol Aero Engines, T.C.A., Spartan, and Canadair. The constructive thinking and foresight of this group proved to be of immense value and resulted in their recommendations being incorporated in the 1955-56 budget.

AUDITED STATEMENT

An audited statement has been prepared by B. A. Armstrong and Company, Chartered Accountants, for the fiscal year ended March 31, 1955, and is attached to this report.

AUDITORS' REPORT

We have examined the accounting records of the Canadian Aeronautical Institute for the year ended 31st March, 1955, but we did not make a detailed examination of all the transactions in the year.

Subject to the foregoing, in our opinion, the above balance sheet and related statement of revenue and expenses have been drawn up so as to show the true and correct view of the financial condition of the Canadian Aeronautical Institute as at 31st March, 1955, and of its operations for the year ended on that date, according to the best of our information and the explanations given to us and as shown by the books.

B. A. ARMSTRONG & CO.
Chartered Accountants

OTTAWA, Ontario,
9th May, 1955.

FINANCIAL STATEMENT
of
CANADIAN AERONAUTICAL INSTITUTE
for
The year ended 31st March, 1955

Statement 1

ASSETS

Current:		
Cash on hand and in bank	$ 3,132.76	
Dominion of Canada bond	1,516.87	
Inventory of pins on hand for resale — at cost	220.34	
Prepaid expenses	60.50	
		$ 4,930.47
Fixed:		
Furniture and fixtures	779.03	
Less: Accumulated depreciation	155.81	
		623.22
		$ 5,553.69

LIABILITIES AND SURPLUS

Liabilities:		
Accrued charges	$ 250.00	
Fees received in advance	992.00	
Journal subscriptions received in advance	400.00	
		$ 1,642.00
Surplus:		
Net revenue for the year — per Statement 2		3,911.69
		$ 5,553.69

REVENUE AND EXPENSES

Statement 2

Revenue:			
Fees — Entrance	$ 1,640.00		
— Regular	3,277.00		
— Sustaining	10,800.00		
	15,717.00		
Less: Refunds to Branches	1,056.00		
		$14,661.00	
Grants		2,300.00	
Pins		285.00	
Meetings		5,559.81	
			$22,805.81

Expenses:		
Accounting and auditing fees	$ 250.00	
Advertising	13.89	
C.A.I. Log	2,191.27	
Certificates	335.20	
Depreciation, furniture and fixtures	155.81	
Incidentals	26.85	
Interest and exchange	92.60	
Meetings	4,646.64	
Pins	143.25	
Postage	439.25	
Printing	262.31	
Rent	780.00	
Salaries	7,787.30	
Stationery and office	1,227.14	
Telephone and telegrams	203.81	
Travelling	318.05	
Unemployment insurance	23.40	
		18,896.77
		3,909.04
Add: Interest on bond		2.65
Net Revenue for the Year —to Statement 1		$ 3,911.69

RECEIPTS AND DISBURSEMENTS

Statement 3

Receipts:			
Fees — Entrance	$ 1,900.00		
— Regular	4,059.00		
— Sustaining	10,800.00		
	16,759.00		
Less: Refunds to Branches	1,106.00		
		$15,653.00	
Grants		2,300.00	
Pins		285.00	
Journal		400.00	
Interest, bond		2.65	
Meetings		5,559.81	
			$24,200.46

Disbursements:		
Advertising	13.89	
Bond, Dominion of Canada	1,516.87	
C.A.I. Log	2,191.27	
Certificates	395.70	
Furniture and fixtures	779.03	
Incidentals	26.85	
Interest and exchange	92.60	
Meetings	4,646.64	
Pins	363.59	
Postage	439.25	
Printing	262.31	
Rent	780.00	
Salaries	7,787.30	
Stationery and office	1,227.14	
Telephone and telegrams	203.81	
Travelling	318.05	
Unemployment insurance	23.40	
		21,067.70
Cash on Hand and in Bank — 31st March, 1955		$ 3,132.76

MEMBERS

NEWS

G. Glinski A.F.C.A.I. has been elected Chairman of the Ottawa Section of the Institute of Radio Engineers.

J. C. Floyd F.C.A.I. has been elected a Fellow of the Royal Aeronautical Society.

V. V. R. Symonds M.C.A.I. formerly of Fleet Manufacturing Ltd., has been appointed Sales Manager (Aircraft) of the Aircraft Division of the Bristol Aeroplane Company of Canada Ltd. He will be located at the Company's offices in the Aviation Building, Montreal.

W/C J. G. Wright A.F.C.A.I. has been selected as the winner of the McKee Trophy for 1955 for his invention of the R Theta Computor.

M. W. MacLeod A.F.C.A.I. was presented with the McCurdy Award for 1954 at the Annual Dinner of the Institute held on the 19th May. See page 83.

ADMISSION PROCEDURE

A good deal of thought has been given to the procedure for admitting members to the C.A.I. The procedure is not unusually slow in comparison with those of other technical societies but it has been criticised as discouraging to those who have eagerly submitted applications, only to find that they must wait two or three months before formal admission is granted. The Council and the Admissions Committee have always been conscious of these criticisms and have constantly endeavoured to simplify and shorten the necessary steps without lowering the standards of grading.

It must be remembered that admission to the C.A.I. does not simply involve admission to membership; it also involves grading, which is important if the Institute is to render the same service to the profession as is rendered by such societies as the R.Ae.S. in Great Britain and the I.A.S. in the U.S.A. And this grading, if it is to earn recognition in the profession, must be very carefully carried out; it is the grading which takes the time.

In the interval between submission of an application and formal admission to membership the applicant enjoys all the privileges of membership (except that he may not vote or hold office); he is immediately placed on the mailing list and receives the Journal, notices of meetings and other correspondence, and he can attend all meetings as if he were a fully admitted member. The only thing lacking is his grade—and the fact that he has not been billed for his entrance fee and dues. In all fairness he must recognize that the delay in his admission is not a very serious hardship.

In the meantime his application is being processed as follows. As soon as it is received at C.A.I. headquarters it is acknowledged, an addressograph plate is prepared and the appropriate Branch Secretary is notified so that he can add the applicant to his mailing list. Form letters are then sent to the references cited by the applicant and the application form is forwarded to the Admissions Committee. The Admissions Committee cannot do very much until at least three of the references have replied—it is therefore in every applicant's own interest to see that his references attend to the matter promptly on receipt of the enquiry from headquarters. However, the Admissions Committee deals with the case as soon as it has some information to work upon.

To minimize inequalities and variations of the interpretation of the By-laws, the Admissions Committee includes representatives of all the Branches and each of these representatives must study each application and express his views on the proper grading. This again is rather a slow process; waiting for the replies from the references was the first delay; obtaining the views of all the members of the Committee is the second. Committees cannot meet every day and usually the files have to be passed round by mail. Finally, when all the members of the Committee have voted, the majority opinion is submitted to the Council —or, between Council meetings, to the Executive Committee—and the Council confirms or rejects the Admissions Committee's grading. Meetings of the Council or Executive Committee take place at intervals of about six weeks, so there may be a further delay in waiting for the next meeting. Borderline cases, which give rise to a lot of discussion to and fro between the Council and the Admissions Committee, are liable to take longer to decide than the more straightforward cases.

From the foregoing it will be seen that the procedure is perhaps rather cumbersome, but it is thorough. Certainly some mistakes in grading have been made but not very many. The Institute is most anxious that its grading should be fair and reliable, and applicants are asked to be patient, bearing in mind that they are not being deprived of any services while their applications are being considered and that, when they are eventually admitted, their grading will have some significance in the profession.

All applications for membership are acknowledged. A few applications seem to have gone astray, and if any member knows of an applicant who has not received an acknowledgement from the Secretary, he should urge him to submit another form.

STUDENTS

With the end of the academic year, Student members who are graduating and leaving their Universities are asked to let the Secretary know their movements. In the first place their addresses will have to be changed in the Institute's records and secondly, upon graduation they no longer qualify for the grade of Student and should be regraded. On receipt of the necessary particulars the Secretary will submit each case to the Admissions Committee.

SUSTAINING MEMBERS

Of The

CANADIAN AERONAUTICAL INSTITUTE

1955 - 1956

Aircraft Industries of Canada Limited
Alloy Metal Sales Limited
Aviation Electric Limited
Aviquipo of Canada Limited
Avro Aircraft Limited
Babb Company (Canada) Limited
Bristol Aeroplane Company of Canada Limited
B. W. Deane & Company
Canadair Limited
Canadian Aviation Electronics Limited
Canadian Car & Foundry Company Limited
Canadian Flight Equipment Limited
Canadian Pacific Air Lines Limited
Canadian Pratt & Whitney Aircraft Company Limited
Canadian Steel Improvement Limited
Cannon Electric Canada Limited
Chatco Steel Products Limited
Computing Devices of Canada Limited
Decca Radar (Canada) Limited
DeHavilland Aircraft of Canada Limited
D. Napier & Son Limited
Dowty Equipment of Canada Limited
Fairey Aviation Company of Canada Limited
Field Aviation Company Limited
Fleet Manufacturing Limited
Garrett Manufacturing Corporation of Canada Limited
General Controls Co. (Canadian) Ltd.
Godfrey Engineering Company Limited
Goodyear Tire & Rubber Company of Canada Limited
Imperial Oil Limited
Jarry Hydraulics
Lucas-Rotax Limited
Minneapolis-Honeywell Regulator Company Limited
Normalair (Canada) Limited
Northwest Industries Limited
Orenda Engines Limited
Prenco Progress & Engineering Corporation Limited
P.S.C. Applied Research Limited
Railway & Power Engineering Corporation Limited
Rolls-Royce of Canada Limited
Ross-Aero Limited
Rousseau Controls Limited
Shell Oil Company of Canada Limited
Simmonds Aerocessories of Canada Limited
Spartan Air Services Limited
Thompson Products Limited
Trans-Canada Air Lines
Walter Kidde & Company Limited
York Gears Limited

THE RUNGE PRESS LIMITED
OTTAWA CANADA